HEWLETT PACKARD

HP 3326A TWO-CHANNEL SYNTHESIZER OPERATING AND REFERENCE MANUAL



HEWLETT PACKARD

OPERATING MANUAL CHANGES

Model Number: **3326A**
Manual Print Date: Sept. 1984
Manual Part Number: Ø3326-9ØØØØ

| New or Revised Item

This supplement contains important information for correcting manual errors and for updating the manual to instruments containing improvements made after printing of the manual.

To use this supplement:

1. Make all Manual **ADDENDA** and **ERRATA** changes.

2. Make all additional changes that pertain to your instrument serial number only.

ERRATA

HP-IB INTRODUCTORY OPERATING GUIDE

Appendix A, Page 12. Change the DCLR front panel control description from "RST DISCRETE" to "CLR DISCRETE".

HP-IB QUICK REFERENCE GUIDE

Page 7, Table 1. In the **INSTR STATE BLOCK** section, change "RST DISCRETE" to "CLR DISCRETE" and "CLR" to "DCLR".

ADDENDA

OPERATION AND REFERENCE MANUAL

Chapter 3, Page 3-1Ø, Figure 3-2. Add "3Ø In 2 TONE mode with channel B high voltage option enabled, channel B frequency cannot track change to channel A frequency".

CHANGE NUMBER 1 for all instruments.

INSTALLATION MANUAL

Page INSTALLATION - 2, Figure 2. Change the 22Ø V/24Ø V fuse type to 2 A 25Ø V NORMAL BLOW, and fuse part number to 2110-ØØØ2.

Page INSTALLATION - 1, POWER REQUIREMENTS paragraph. Change the "2ØØ VA" power rating to "29Ø VA" and the "15 VA" power rating to "1ØØ VA".

OPERATING AND REFERENCE MANUAL

Chapter 1, Page 1-11. After the third sentence of the Combined Operation paragraph, add: "When COMBINED operation is enabled, either a DC function, or a high voltage output may be selected."

Appendix B, Page B2. Change the notes for **Sine/Sine Outputs** table to "1 = Both amplitude levels" and "2 = Both amplitude levels".

Appendix B, Page B2. Change the notes for **Square/Square Outputs** table to "1 = Both amplitude levels" and "2 = Both amplitude levels".

Appendix B, Page B4. Change the last line of the **EXTERNAL REFERENCE INPUT** specification to "is ±1°/°C" (one degree per degree centigrade.

Appendix B, Page B4. Change the page reference in the **PHASE NOISE** specification to "B1".

Appendix B, Page B5. Change the **POWER** specifications to "100/120/220/240V, +5%, -10%, 48 to 66 Hz, 120 VA, 290 VA with all options, 100 VA standby."

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CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

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OPERATING MANUAL

MODEL 3326A
TWO-CHANNEL SYNTHESIZER

WARNING

To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.

Manual Part No. P/O 03326-90000

Microfiche Part No. 03326-90050

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

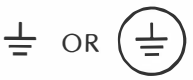
General Definitions of Safety Symbols Used On Equipment or In Manuals.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.



Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Alternating current (power line).



Direct current (power line).



Alternating or direct current (power line).

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE

The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

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CHAPTER 1
OPERATION AND REFERENCE

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CHAPTER I

OPERATION AND REFERENCE

This chapter contains a description of the manual operation of the HP 3326A Two Channel Synthesizer. This chapter is subdivided into sections describing each major function of the HP 3326A. The sections contained in this chapter are listed in the table of contents printed on the chapter divider.

CAUTION

Prior to operating the HP 3326A, check that the fuse rating and line voltage setting are correct for the local ac power source. The POWER REQUIREMENTS section in the HP 3326A Installation Manual contains information on setting the line voltage selector and selecting the fuse of the HP 3326A for the local ac power source.

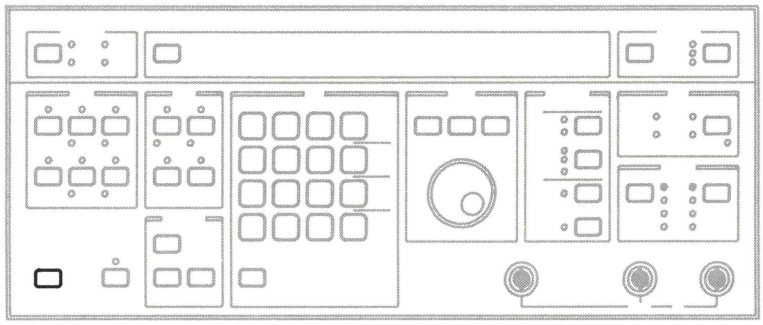
NOTE

A fold out page located at the back of this manual illustrates the front and rear panel controls, connectors, and indicators on the HP 3326A. This illustration can be extended for easy reference while reading this manual.

Examples of HP-IB commands that correspond to front panel keys are listed after the front panel key description. HP-IB commands are used for remote operation of the HP 3326A with a controller. A complete list of HP-IB commands is included in Chapter III, "HP 3326A HP-IB COMMANDS."

HP 3326A TURN ON AND WARM UP

Turn On and Power Up Self Tests



POWER

Connect the HP 3326A to a suitable power source and depress the POWER switch to apply power to the entire HP 3326A. When power is applied, the HP 3326A initially displays "HP 3326A" followed by a list of the options installed. The HP 3326A then initiates a series of self tests and calibrates internal circuits. During a self test, all indicators (except the EXT REF indicator) and display segments are illuminated then extinguished, and a series of internal tests are initiated. After each internal test, PASS or FAIL followed by a test number is displayed to indicate the test results. During a self test, the outputs are disabled.

When power is removed from the HP 3326A with the POWER key, the HP 3326A is in a standby condition. In the standby condition, power is applied to the high stability frequency reference circuits (Option 001) to maintain frequency accuracy.

Turn On State

The initial state of the HP 3326A at power up is dependent upon the setting of internal switches. The normal turn on state is the preset state described in "The Preset State and the INSTR PRESET Key". However, through the use of the internal SAVE switch, the setup state selected prior to removing power can be selected as the turn on state. Setting of internal switches must be done by qualified service personnel. The location and settings of the SAVE switch are described in the HP 3326A Service Manual.

Warm Up

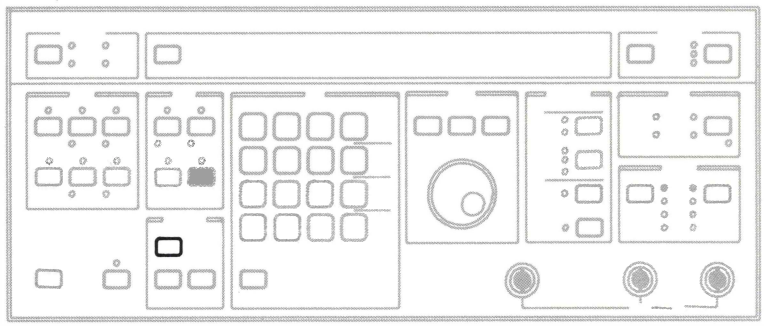
An HP 3326A without the high stability frequency reference (Option 001) requires 30 minutes of operation to meet all specifications. An HP 3326A with Option 001 requires 15 minutes of operation to meet frequency specifications if power is disconnected for less than 24 hours. If power is disconnected from the HP 3326A with Option 001 for

more than 24 hours, up to 72 hours of operation may be required to meet frequency specifications. The HP 3326A with Option 001 requires 30 minutes of operation to meet other specifications.

NOTE

When power is removed from the HP 3326A with the POWER key, the HP 3326A is in a standby condition. In the standby condition, power is applied to the high stability frequency reference circuits (Option 001) to maintain frequency accuracy.

The Preset State and the Instr Preset Key



INSTR PRESET

The preset state of the HP 3326A is listed in Figure 1-1. The HP 3326A is restored to the preset state by pressing the green INSTR PRESET (INSTRument PRESET) key. INSTR PRESET provides a convenient starting state for establishing an instrument setup. INSTR PRESET does not destroy instrument states or discrete frequency sweep elements stored in the internal nonvolatile memory.

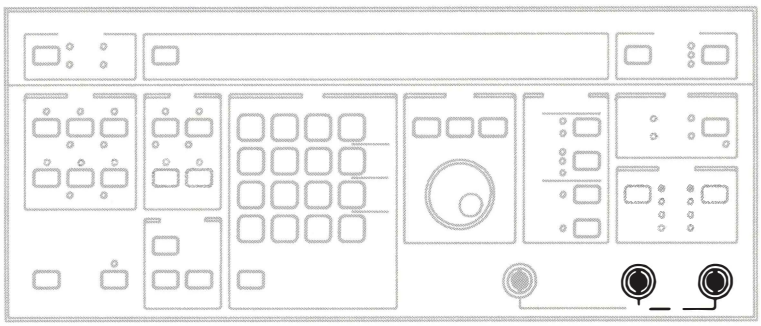
HP-IB Example:

"RST"

KEY GROUP	KEY	PRESET STATE/VALUE
MODE	MODE	2 CHANNEL
	COMBINED	Off
FUNCTION	CH A	Sine wave
	CH B	Sine wave
	CH A HV	Off
	CH B HV	Off
STATUS	CHAN	Channel A
ENTRY	FREQ	1 kHz
	DUTY CYCLE	50 %
	AMPTD	0.1 V Peak-to-peak
	% AM/PM DEV	30% (AM) / 108° (PM)
	PHASE	0°
	ASSIGN ZERO ϕ	—
	DC OFFSET	0 V
	CLR ϕ OFS	—
SWEEP	CONT	Disabled
	START FREQ	0 Hz
	CNTR FREQ	6.5 MHz
	STOP FREQ	13 MHz
	SPAN	13 MHz
	SINGLE	Disabled
	RESET SWP	—
	MKR FREQ	6.5 MHz (Channel A)
	TRIANGLE	Ramp selected
	TIME	1 second
	DISCRETE	Disabled (Linear sweep)
CALIBRATION	MANUAL	—
	AUTO	Disabled
	SELECT	INTERNAL
	SELF TEST	—
MODULATION	—	Off
MODIFY	ON/OFF	Off
UNGROUPED KEYS	SHIFT	Off
TRIGGER SIGNAL	—	Single sweep pending
HP-IB STATUS	LOCAL	No effect
	BUS ADRS	No effect

Figure 1-1. HP 3326A Preset State

CH A AND CH B OUTPUTS



CH A and CH B Output Connectors

The CH A (channel A) and CH B (channel B) output connectors are normally located on the front panel. Option 003, Rear Panel Main Signal Outputs, replaces the front panel channel A and B outputs with rear panel outputs.

The channel A connector, in addition to being the output for channel A, is also the active output for combined and internal modulation operation. For combined and internal modulation operation, the channel B output is is used internally and is unavailable at the CH B connector.

The output impedance is 50 Ω from 0 to 100 kHz, with a return loss of greater than 20 dB over the range of 100 kHz to 13 MHz. The output impedance with the high voltage option enabled is less than 2 Ω from 0 to 50 kHz, and less than 10 Ω over the range of 50 kHz to 1 MHz. Both outputs share the same ground and may be floated up to ±42 volts peak.

⚠ **WARNING**

The maximum peak voltage (ac + dc) that can be safely applied between chassis and the outer conductor of the HP 3326A input and output connectors is ±42 volts peak.

Setup For Viewing Output Waveforms

Figure 1-2 illustrates a simple setup to view the HP 3326A outputs and observe the effects of changing the HP 3326A settings. For example purposes, the selection of an oscilloscope is not critical although a dual channel oscilloscope has the advantage of displaying both channels simultaneously.

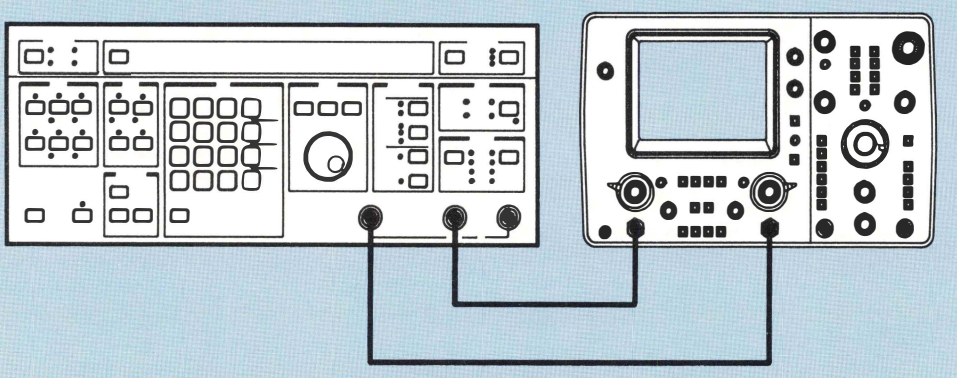
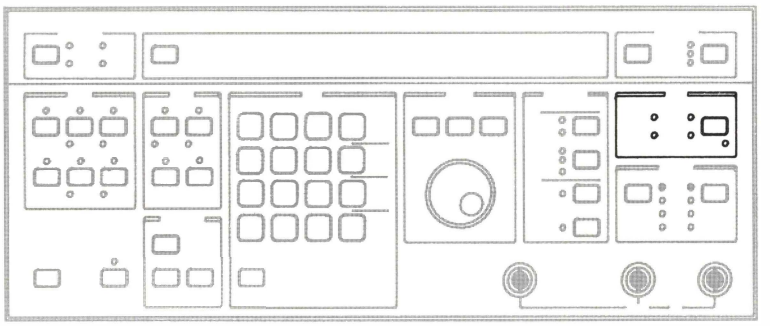


Figure 1-2. Connections for Viewing Output

SELECTING AN OPERATING MODE

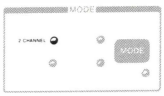


The Mode Key

MODE

The MODE key selects the operating mode of the HP 3326A. Each time the MODE key is pressed, the operating mode sequences through the 2 CHANNEL, 2 PHASE, 2 TONE, and PULSE operating modes. The mode selected is indicated by the illuminated indicator. COMBINED operation is enabled by pressing the blue SHIFT key prior to the MODE key. The operating modes affect operating limits, operating characteristics, and selection of the CH A and CH B outputs. The effects on the operating characteristics and limits are included in the applicable sections for the characteristics and limits. When the 2 PHASE or PULSE mode is selected, the HP 3326A performs an internal phase calibration. During a mode change, the channel A and B outputs are disabled.

2 Channel Mode



In the 2 CHANNEL mode, the HP 3326A operates as two independent synthesizers. Sweep parameters, frequency, amplitude, dc offset, external modulation, sine wave output, and square wave output is independent for each channel. With internal modulation enabled, the channel B synthesizer is used to internally modulate the channel A synthesizer. Figure 1-3 illustrates the effect of changing frequency in the 2 CHANNEL mode.

HP-IB Examples:

"MODE1"
or
"MODE TWOC"

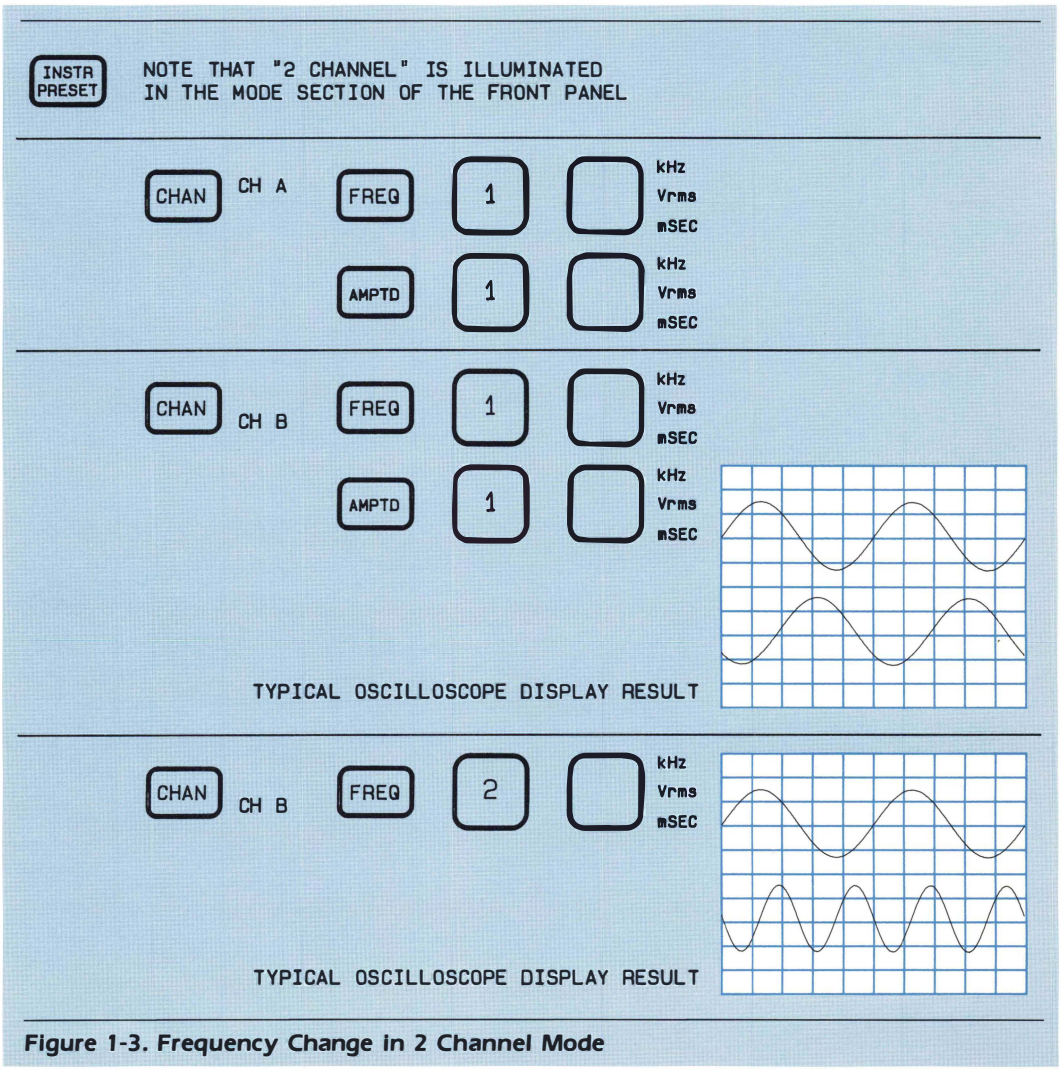
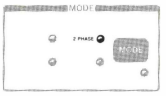


Figure 1-3. Frequency Change in 2 Channel Mode

2 Phase Mode



In the 2 PHASE mode, both channel A and B frequencies are the same (see Figure 1-4). The phase offset of channel B with respect to channel A remains constant as frequency is changed. Amplitude, dc offset, external amplitude modulation, sine wave output, and square wave output is independent for each channel.

HP-IB Examples:

"MODE 2"
or
"MODE TWOP"

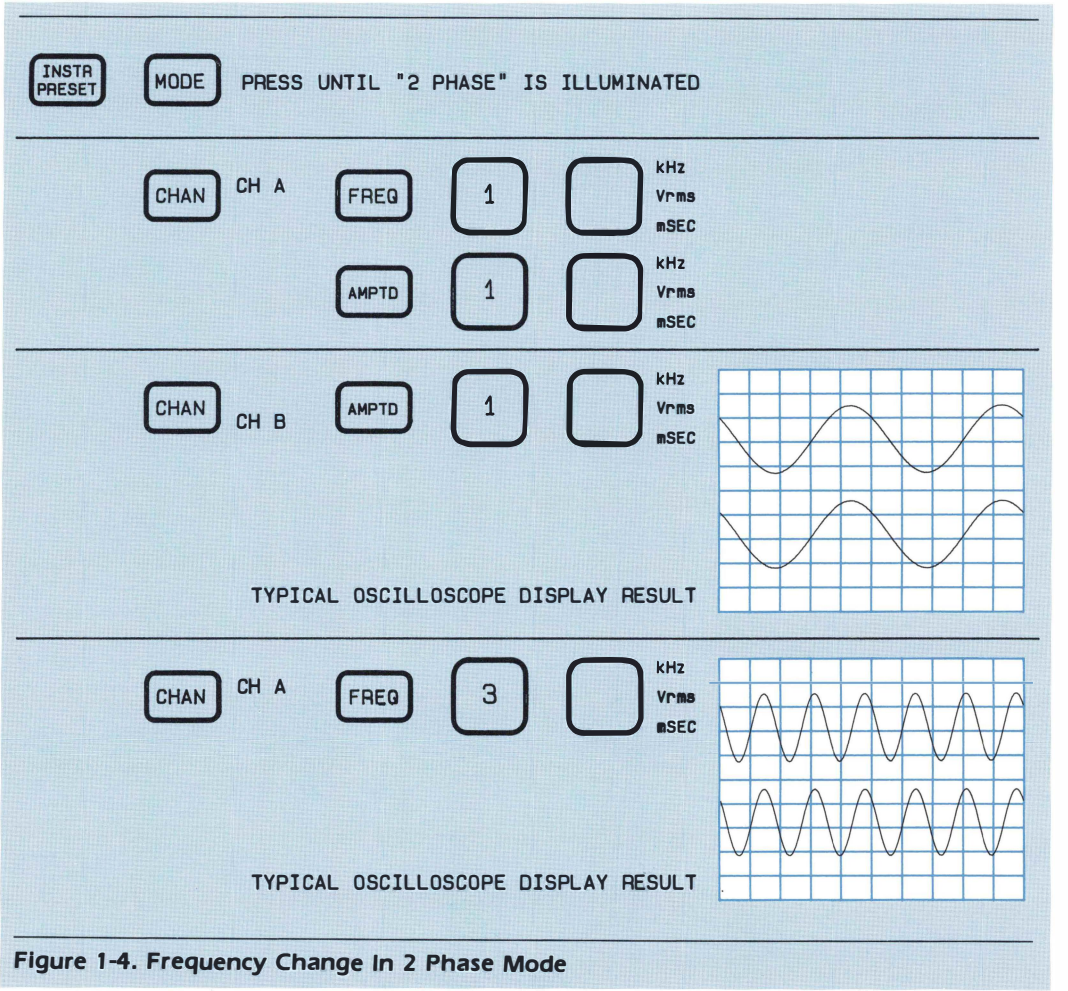


Figure 1-4. Frequency Change In 2 Phase Mode

2 Tone Mode



In the 2 TONE mode, the channel B frequency tracks changes to the channel A frequency (see Figure 1-5). The maximum frequency difference between channel A and channel B is 100 kHz. Amplitude, dc offset, external amplitude modulation, sine wave output, and square wave output are independent for each channel.

HP-IB Examples:

"MODE3"
or
"MODE TWOT"

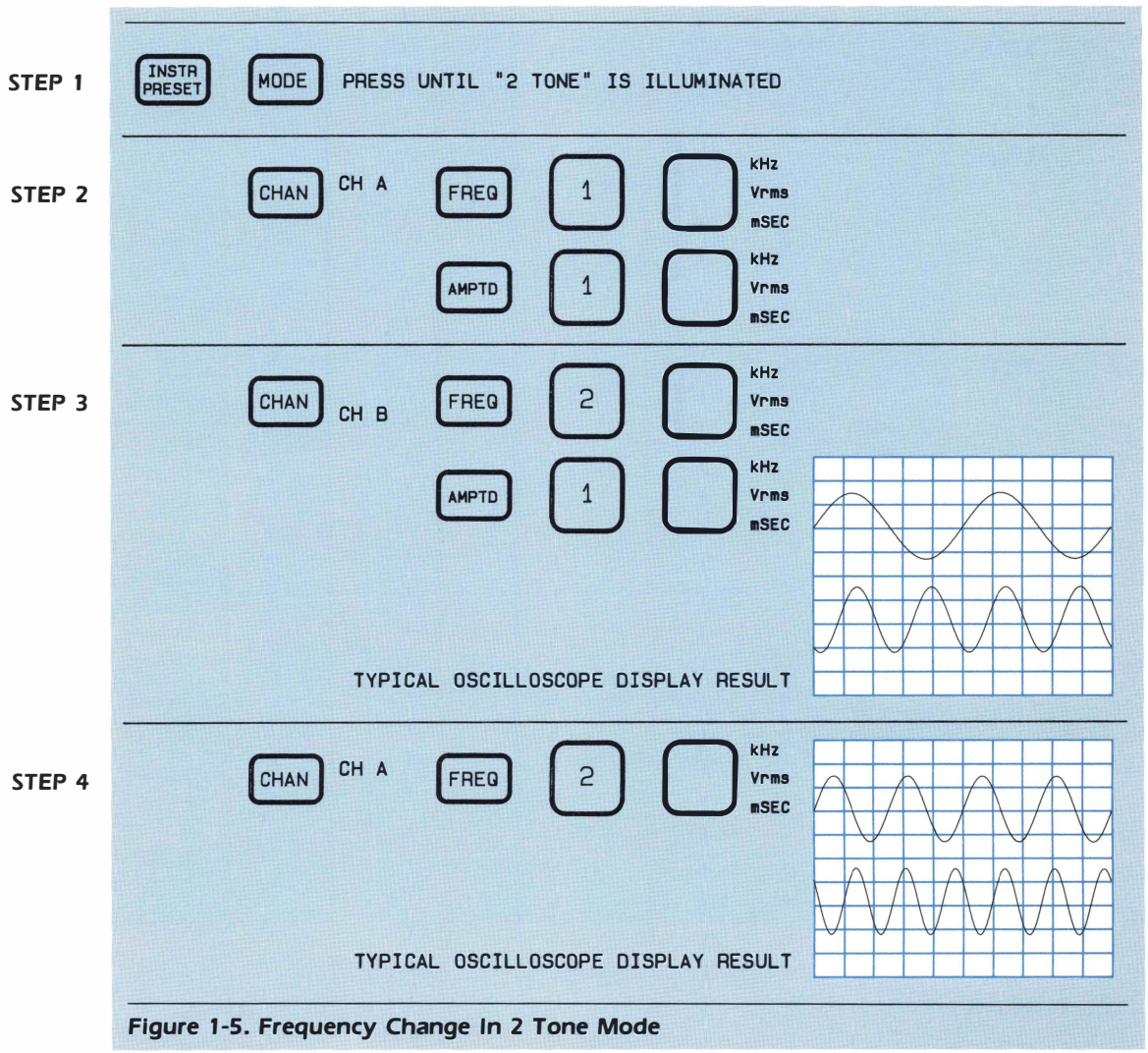
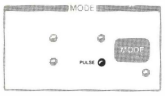


Figure 1-5. Frequency Change In 2 Tone Mode

Pulse Mode



In the PULSE mode, the channel B square wave output is the complement of the channel A square wave output (see Figure 1-6). Amplitude, dc offset, and external amplitude modulation are independent for each channel.

HP-IB Examples:

"MODE4"
or
"MODE PULS"

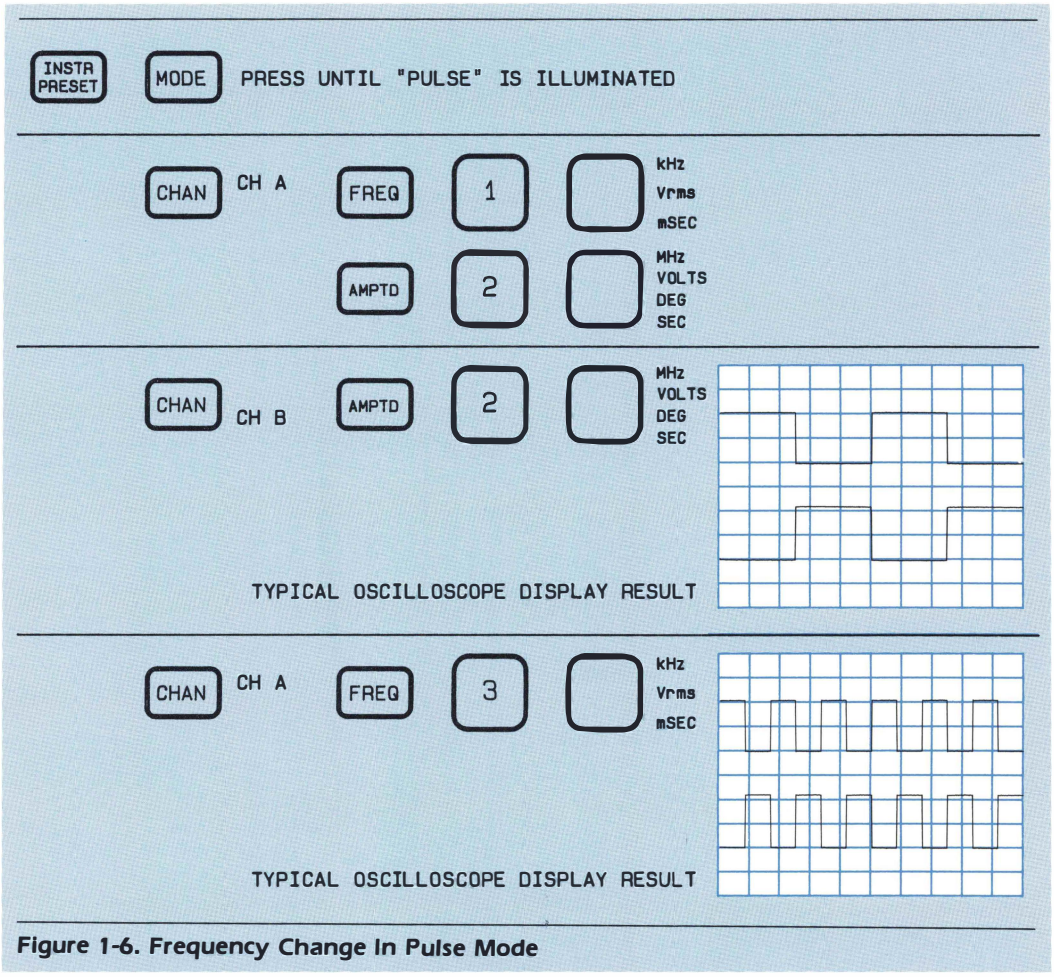
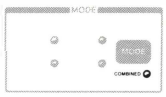


Figure 1-6. Frequency Change In Pulse Mode

Combined Operation



With COMBINED operation, the channel B output is diverted and summed with the channel A output (see Figure 1-7). COMBINED operation reduces the amplitude output limit of each channel by 50% (6.02 dB) and sets the dc offset level to zero. DC offsets can be entered if DC is selected as the function, however, when alternate functions (OFF, sine wave, or square wave) are selected, the DC offset level is returned to zero. Note that the peak-to-peak amplitude of the output signal is a function of the phase, frequency, and amplitude of each channel. COMBINED operation is selectable only in the 2 CHANNEL, 2 PHASE, and 2 TONE MODES. COMBINED operation is disabled for internal modulation.

HP-IB Examples:

"CMB1"
or
"CMB ON"

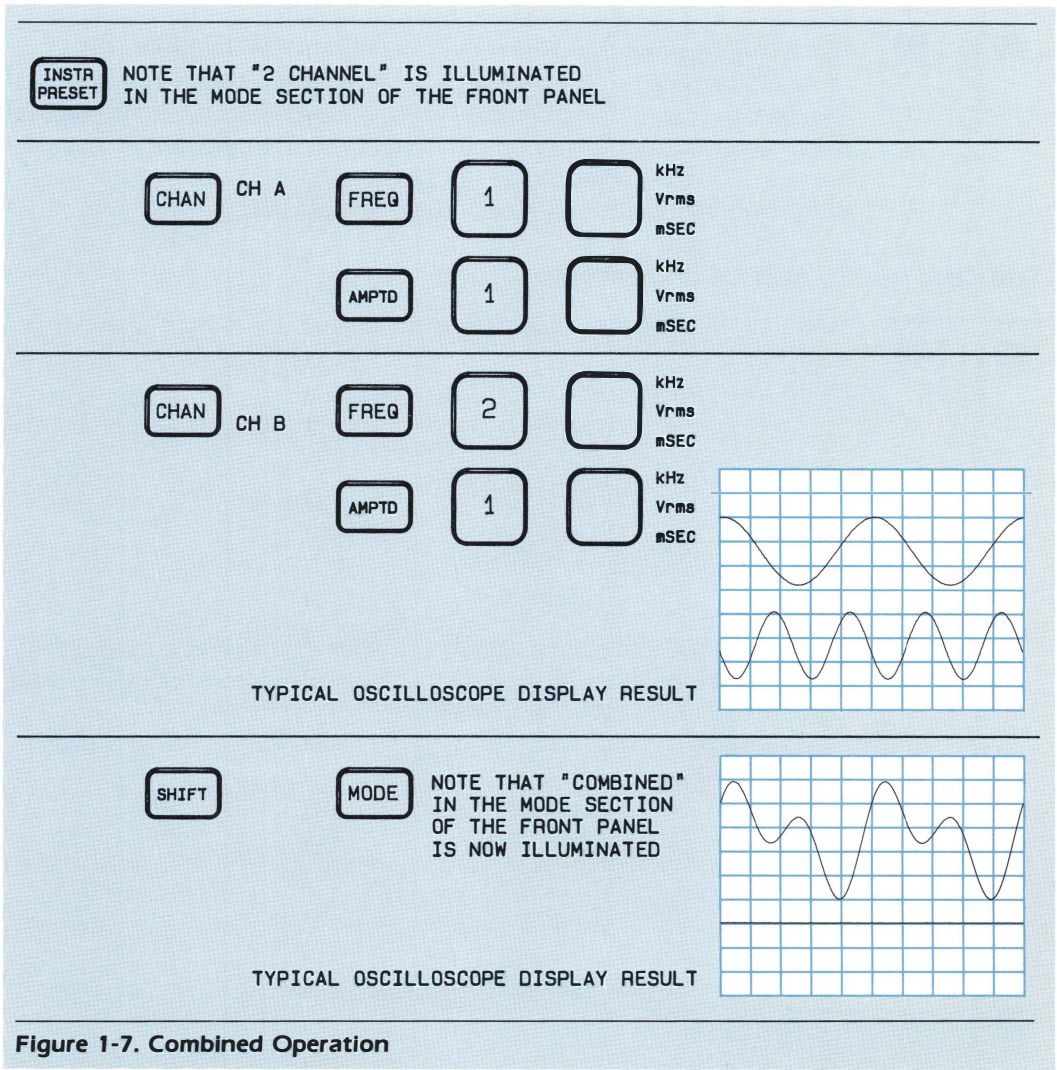
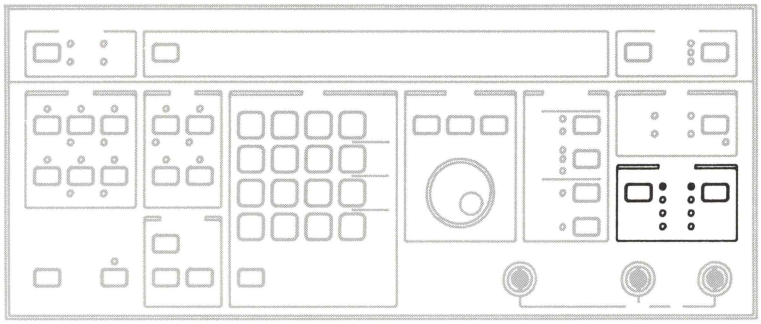
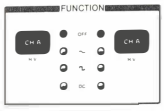


Figure 1-7. Combined Operation

SELECTING THE OUTPUT FUNCTION

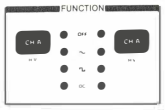


The CH A and CH B Keys



The CH A and CH B keys select the output waveform for the channel A and channel B outputs, respectively. Each time the CH A or CH B key is pressed, the output waveform sequences through the OFF, ~ (sine wave), ⊓ (square wave), and DC outputs. The selected output is indicated by an illuminated indicator. If the pulse mode is selected, the sine wave and DC only output is removed from the output waveform selection sequence. The blue high voltage (HV) legends printed below these keys are active only if the high voltage option (Option 002) is installed.

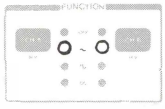
The Off, ~, ⊓, and DC Indicators



When all function indicators are extinguished, the output channel is disabled.

HP-IB Examples:

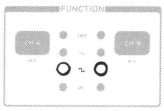
"FCNA0"
or
"FCNA OFF"
"FCNBO"
or
"FCNB OFF"



The ~ (sine wave) indicator illuminates when a sine wave output is enabled. If the pulse mode is selected, the sine wave output is removed from the output waveform selection sequence.

HP-IB Examples:

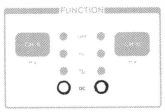
"FCNA1"
or
"FCNA SIN"
"FCNB 1"
or
"FCNB SIN"



The ⊓ (square wave) indicator illuminates when a square wave output is enabled.

HP-IB Examples:

"FCNA2"
or
"FCNA SQR"
"FCNB 2"
or
"FCNB SQR"

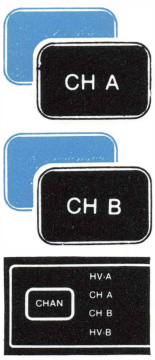


The DC indicator illuminates when a dc only output is enabled. With dc only, the ac portion of the output is suppressed. The output amplitude for the DC function is controlled by the value entered for the DC OFFSET key.

HP-IB Examples:

"FCNA3"
or
"FCNA DC"
"FCNB3"
or
"FCNB DC"

The High Voltage Option (Option 002)



The HV (high voltage) key enables or disables the high voltage output option. The HV key is available by pressing the blue SHIFT key prior to pressing the CH A or CH B key. An HV indicator, to the left of the display, illuminates when a high voltage output is enabled. The high voltage option increase the available output voltage range by a factor of four with a maximum value of 40 volts peak-to-peak. Enabling the high voltage option reduces the maximum output frequency to 1 MHz, and decreases the output impedance. The output signal is momentarily set at zero volts if internal attenuator settings change.

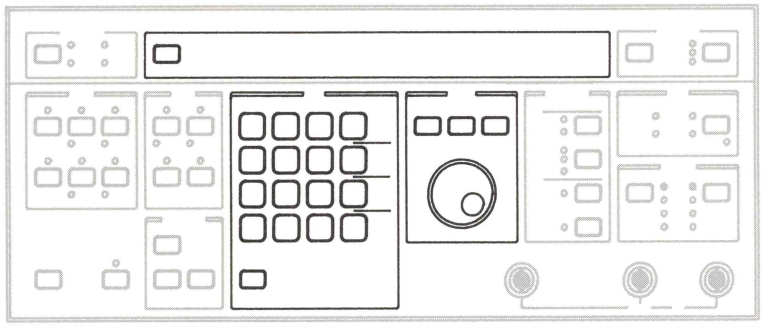
NOTE

The channel B high voltage option is disabled if the channel A frequency is greater than 1 MHz and the HP 3326A mode is changed. The channel B frequency must be reduced below 1 MHz before the high voltage option can be enabled.

HP-IB Examples:

"HVA1" "HVB1"
or or
"HVA ON" "HVB ON"

DATA ENTRY AND MODIFICATION



Selecting the Channel for Modification

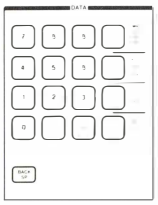


Prior to entering data to specify the HP 3326A output, it is necessary to select the channel to be modified with the CHAN key to the left of the display window. The channel currently selected is indicated by the illuminated CH A or CH B indicator next to the CHAN key. The CHAN key selects the alternate channel for display and modification each time the CHAN key is pressed.

HP-IB Examples:

"CHA"
"CHB"

The Data Keys



Entering setup values with the numeric keypad is a simple three step process. Select a parameter to change, enter the desired value (most significant digit first), and end the entry with a units key. For example, to change the output amplitude to 1 Vrms, press the AMPTD (amplitude) key and display the current amplitude value. Press the 1 key in the numeric keypad, and press the kHz Vrms mSEC units key to end the entry (see Figure 1-9). Notice that the Vrms units from the kHz Vrms mSEC units key are assigned to the data value. The HP 3326A assigns the units to the data value that corresponds to parameter being changed. If the entered value exceeds the HP 3326A range limits, the entered value is ignored and an error message is displayed. To cancel an incomplete data entry, press any key that requires the display for data entry (see Figure 1-8). lists the keys that accept numeric data.

AMPTD	RCL DISCRETE
BUS ADRS	SAVE
CNTR FREQ	SAVE DISCRETE
DC OFFSET	SPAN
DUTY CYCLE	START FREQ
FREQ	STOP FREQ
MKR FREQ	TIME
PHASE	% AM/PM DEV
RECALL	

Figure 1-8. Keys That Accept Data Values



The value in the display window is edited during data entry with the BACK SPACE key. Each time the BACK SPACE key is pressed, the least significant digit or decimal point is removed from the display. After the incorrect digits are removed from the display value, data entry can continue with the numeric keypad and units keys. Figure 1-9 illustrates the use of the BACK SPACE key.

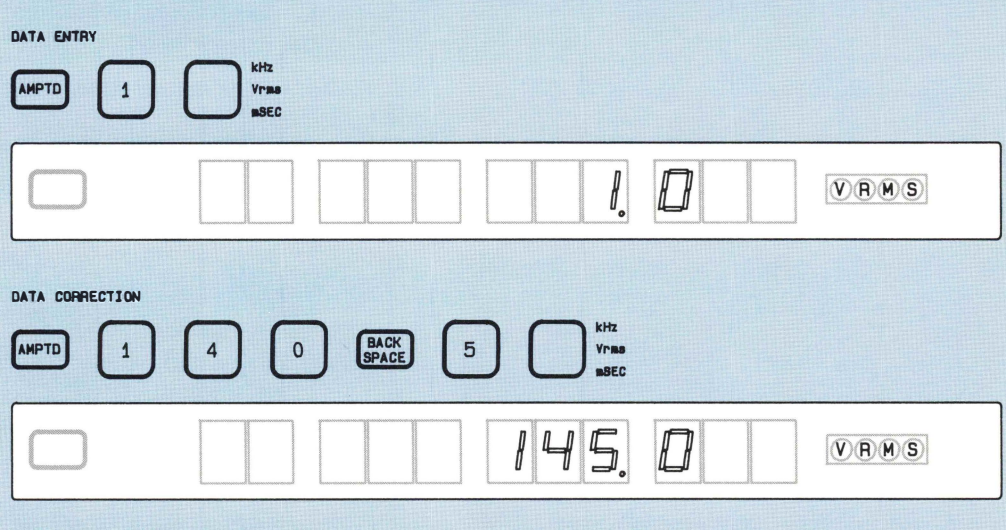


Figure 1-9. Data Entry Example

Error Messages

If an attempt is made to enter or modify operating parameters beyond the HP 3326A capabilities, the new input is ignored and an error message and code is displayed. Figure 1-10 lists the error messages and explanations of the errors. A complete list of the error messages and codes is included in Appendix A.

ERROR MESSAGE	CODES	DESCRIPTION
SNTX	10	(HP-IB SyNTaX) AN HP-IB command has a syntax error.
RMOT	11	(ReMOTe) A front panel key is pressed while the HP 3326A is in remote.
LOCK	12	(local LOCKout) The LOCAL key is pressed while the HP 3326A is in local lockout.
RNGE	20, 26, 29	(RaNGE) The value entered for the selected parameter exceeds the valid limits.
INTR	40, 46, 47	(INTeRrogate) The value of the function requested cannot be displayed because of the mode, modulation, channel, or sweep selected.
CNVT	50	(CoNVerTs) The units conversion requested results in an invalid zero display value.
SUFX	60, 65	(SUFfiX) The units key selected is improper for the function selected.
INC	70	(INCrement) The increment value or units used over the HP-IB is incompatible with the displayed value.
AMPL	80	(AMPLitude) Combined operation is selected and the current amplitude is too large.
MODL	86	(MODuLation) The requested value is incompatible with the modulation mode selected.
MODE	87	(MODE) The requested value or function is incompatible with the mode selected.
FREQ	88	(FREQuency) The channel B frequency value is too large for modulation.
CMBR	89	(CoMBineR) The requested value or function is incompatible with combined operation.
SWFR	90, 95, 96	(SWeep FRequency) The sweep frequencies are not valid for sweep operation, high voltage option, internal PM, or internal AM.
DUTY	94	(DUTY cycle) The duty cycle of a PULSE is too narrow for a sweep.
RATE	100	(RATE) The sweep rate is less than 5 mHz/s or greater than 0.5 MHz/ms.
DSWP	110, 114	(DiScrete frequency SWeeP) The discrete frequency sweep is invalid because of mode selected or the lack of sweep elements.

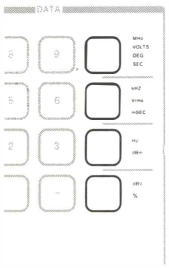
Figure 1-10. Error Messages

DSHV	115	(Discrete Sweep High Voltage) The high voltage option is enabled and a discrete frequency element frequency exceeds 1 MHz.
DSML	116	(Discrete Sweep ModuLation) The channel B frequency exceeds the 5 kHz internal Pm limit or exceeds the 100 kHz internal AM limit during a discrete frequency sweep.
DSMD	117	(Discrete Sweep MoDe) The discrete frequency sweep elements in memory are incompatible with the mode selected.
P OF	120	(Phase OFfset) Cannot clear phase offset of channel A.
H V	130, 136, 138	(High Voltage) The high voltage (HV) option cannot be enabled because the output frequency is greater than 1 MHz, the option is not installed, or modulation is enabled.
CSUM	140	(CheckSUM) An error is detected in setup data when recalled from memory.
CRPT	160	(CoRruPT) An error is detected in an instrument state recalled from memory. The instrument state is replaced with the preset state.
A OL	170	(A OverLoad) The channel A output is overloaded. The load impedance for the channel A output is too low or a voltage source is attached to the channel A output.
B OL	171	(B OverLoad) The channel B output is overloaded. The load impedance for the channel B output is too low or a voltage source is attached to the channel B output.
SYOL	172	(SYnc OverLoad) The SYNC A output is overloaded. The load impedance attached to the SYNC A output is too low or a voltage source is attached to the SYNC output.
AVCO	173	(channel A Voltage Controlled Oscillator) The channel A voltage controlled oscillator is unlocked.
BVCO	174	(channel B Voltage Controlled Oscillator) The channel B voltage controlled oscillator is unlocked.
XREF	180	(eXternal REFerence) An external reference signal is sensed, but the HP 3326A cannot lock to it.
MCAL	190	(Modulation CALibration) An internal AM or PM calibration is unsuccessful.
PCAL	191	(Phase CALibration) A phase calibration is unsuccessful.
ACAL	192	(Amplitude CALibration) An amplitude calibration is unsuccessful.
OCAL	193-194	(Offset CALibration) A dc offset calibration is unsuccessful.
PASS	—	A self test is successful.
FAIL	—	A self test is unsuccessful.

Viewing Setup Parameters

The current value of a setup parameter is displayed when a front panel key that accepts entries from the keypad (such as the FREQ or AMPTD key) is pressed. Figure 1-8 lists the front panel keys that accept entries from the keypad. Selecting one of these keys does not alter the current setup values. An error message is displayed if the key pressed is inactive for the mode selected. Pressing the CHAN key alternates the display between the channel A and B values for the parameter selected.

Units Conversion



The units keys, in addition to ending data entry, can perform units conversion on displayed values. Pressing a units key converts the value to the equivalent value for the units key pressed. For example, if the display value is in dBm, pressing the dBV % units key converts the display value to dBV. Converting units does not alter the current setup. The message "Error 50 CNVT" (CoNVerT) is displayed if the conversion would results in a zero display value that is inconsistent with the current value. For example, converting 0.000001 Hz to MHz would erroneously display 0 MHz. Figure 1-11 illustrates units conversion.

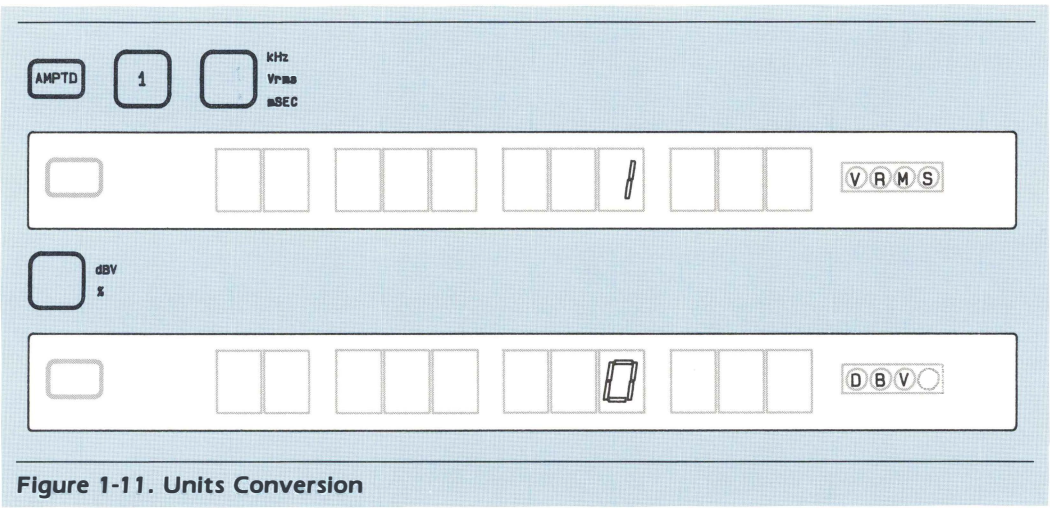


Figure 1-11. Units Conversion

Modifying Entry Values with the Rotary Knob



The display value can be modified with the rotary knob and keys in the MODIFY control group (see Figure 1-12). The rotary knob is enabled with either the arrow keys or ON/OFF key. When the modify rotary knob is enabled, a single digit in the display flashes. The flashing digit is the least significant digit that is modified with the rotary knob. Turning the rotary knob clockwise increments the value of the display, while turning the rotary knob counterclockwise decrements the value of the display. The rotary knob modifies the display value until the boundary limit is reached. The rotary knob (and flashing digit) is disabled with the ON/OFF key. Figure 1-13 lists the display values that are modified with the rotary knob.

The display digit modified with the rotary knob is selected with the right arrow and left arrow keys. Pressing the right arrow key selects the next least significant digit for modification and pressing the left arrow key selects the next most significant digit for modification.

HP-IB Examples:

"MFY1"
or
"MFY ON"

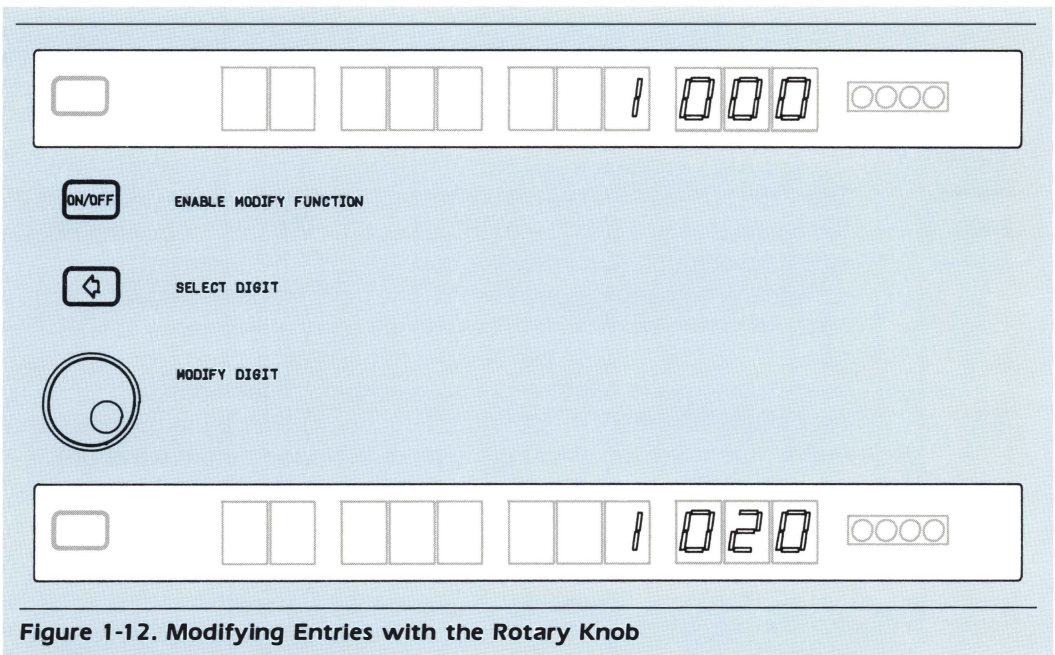
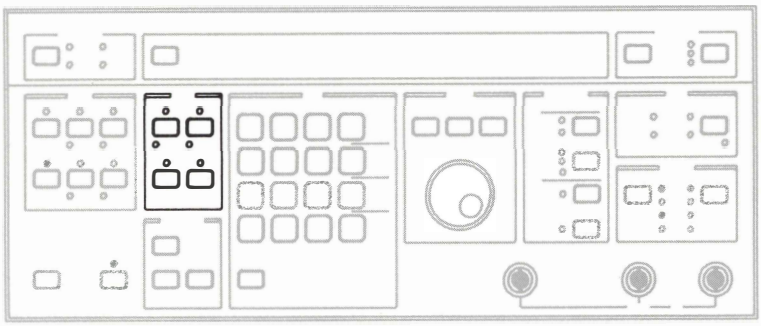


Figure 1-12. Modifying Entries with the Rotary Knob

AM PERCENT MODULATION	FREQUENCY	START FREQUENCY
AMPLITUDE	MARKER FREQUENCY	STOP FREQUENCY
DC OFFSET	PHASE	TIME
DUTY CYCLE	PM PEAK DEVIATION	
CENTER FREQUENCY	SPAN	

Figure 1-13. Parameters Modified with the Rotary Knob

THE ENTRY KEYS



Frequency



The FREQ (frequency) key enables display, entry or modification of the frequency of the channel selected with the CHAN key. The indicator above the FREQ key illuminates when the output frequency value is displayed. The displayed frequency value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies beleow 100 kHz, and 1 mHz for 100 kHz and above. Frequency ranges are dependent upon selection of the operating mode and high voltage option (see Figure 1-14). During a frequency change the output is phase continuous; that is, there are no phase discontinuities in the output waveform.

NOTE

After a mode change, the channel B frequency is set to the channel A frequency.

2 Channel Mode

Each channel frequency is set independently. The frequency range for each channel is 0 to 13 MHz.

2 Phase or Pulse Mode

The frequency of both channels is set to the same value by a change in frequency of either channel. The frequency range is 0 to 13 MHz.

2 Tone Mode

The channel B frequency tracks changes to the channel A frequency. The frequency range of channel A is 0 to 13 MHz. The channel B frequency can have up to a 100 kHz offset from channel A with a maximum frequency of 13.1 MHz. If a channel A frequency change forces the channel B frequency to less than zero, the channel B frequency is changed to a value equal to the channel A frequency plus the absolute value of the offset. The negative channel B value is displayed, and the channel B output frequency is the absolute value of the displayed value.

Internal Phase Modulation

The frequency range of channel A is 0 to 13 MHz. The frequency range of channel B is 0 to 5 kHz.

Internal Amplitude Modulation

The frequency range of channel A is 0 to 13 MHz. The frequency range of channel B is 0 to 100 kHz.

HV Option

With the high voltage option enabled, the frequency output is 0 to 1 MHz. In the 2 TONE mode, the maximum channel B frequency is 1.1 MHz.

NOTE

After a mode change, the channel B frequency is set to the channel A frequency. If the channel B frequency is set to greater than 1 MHz, the channel B high voltage option is disabled. To enable the high voltage option, reduce the channel B frequency to below 1 MHz.

HP-IB Example:

"FR7.500003MHZ"

MODE	CH A	CH B	NOTES
2 CHANNEL	0 - 13 MHz	0 - 13 MHz	
2 PHASE	0 - 13 MHz	0 - 13 MHz	Channel A frequency = channel B frequency. Set by either channel.
2 TONE	0 - 13 MHz	CH A ± 100 kHz (13.1 MHz max.)	Channel B tracks Channel A. Changing channel B changes frequency offset.
PULSE	0 - 13 MHz	0 - 13 MHz	Channel A frequency = channel B frequency. Set by either channel.
INTERNAL PHASE MODULATION	0 - 13 MHz	0 - 5 kHz	
INTERNAL AMPLITUDE MODULATION	0 - 13 MHz	0 - 100 kHz	
HV OPTION	0 - 1 MHz	0 - 1 MHz	(Channel B frequency 0-1.1 MHz in 2 Tone)

Figure 1-14. Frequency Limits

Amplitude

AMPTD

The AMPTD (amplitude) key enables display, entry, or modification of the amplitude of the channel selected with the CHAN key. The indicator above the AMPTD key illuminates when an amplitude value is displayed. The displayed amplitude value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The VOLTS, Vrms, dBm, and dBV units allow convenient entry of amplitude values. The amplitude range without dc offset is from 1 mV peak-to-peak to 10 V peak-to-peak (4 mV peak-to-peak to 40 V peak-to-peak with high voltage enabled). The amplitude range is dependent upon selection of COMBINED operation, internal modulation, dc offset, and high voltage option (see Figure 1-15). The output signal is momentarily set at zero volts if internal attenuator settings change.

HIGH VOLTAGE	COMBINED	DC OFFSET	MAXIMUM AMPLITUDE	NOTES
OFF	OFF	OFF	10 Vpp	
ON	OFF	OFF	40 Vpp	
OFF	ON	OFF	5 Vpp	
ON	ON	OFF	20 Vpp	
OFF	OFF	ON	± 5 Vpk	AC + DC
ON	OFF	ON	±20 Vpk	AC + DC
OFF	ON	ON	±2.5 Vpk	DC only FUNCTION
ON	ON	ON	± 10 Vpk	DC only FUNCTION

Figure 1-15. Maximum Amplitudes

Internal Modulation

With internal modulation, the channel B amplitude is controlled by the % AM/PM DEV key. Internal modulation uses the channel B output internally and a signal is unavailable at the CH B connector.

High Voltage Option

With the high voltage option, the upper amplitude limit is increased to 40 volts peak-to-peak and the lower amplitude limit is increased to 4 mV peak-to-peak. The high voltage output needs to be enabled prior to entering voltage values greater than 10 volts.

Combined

For COMBINED operation, the output of channel B is diverted and summed with the channel A output. The amplitude limit of each channel is reduced by 50% (6.02 dB). The upper amplitude limit for COMBINED operation is ±5 volts (±20 volts with the high voltage option enabled). Note that the output amplitude level is dependent upon phase, frequency, and amplitude values.

DC Offset

The limit for an ac output with a dc offset is ± 5 volts peak (± 20 volts peak with the high voltage option enabled). Figure 1-16 illustrates dc offset versus amplitude.

HP-IB Example

"AM1.125VO"

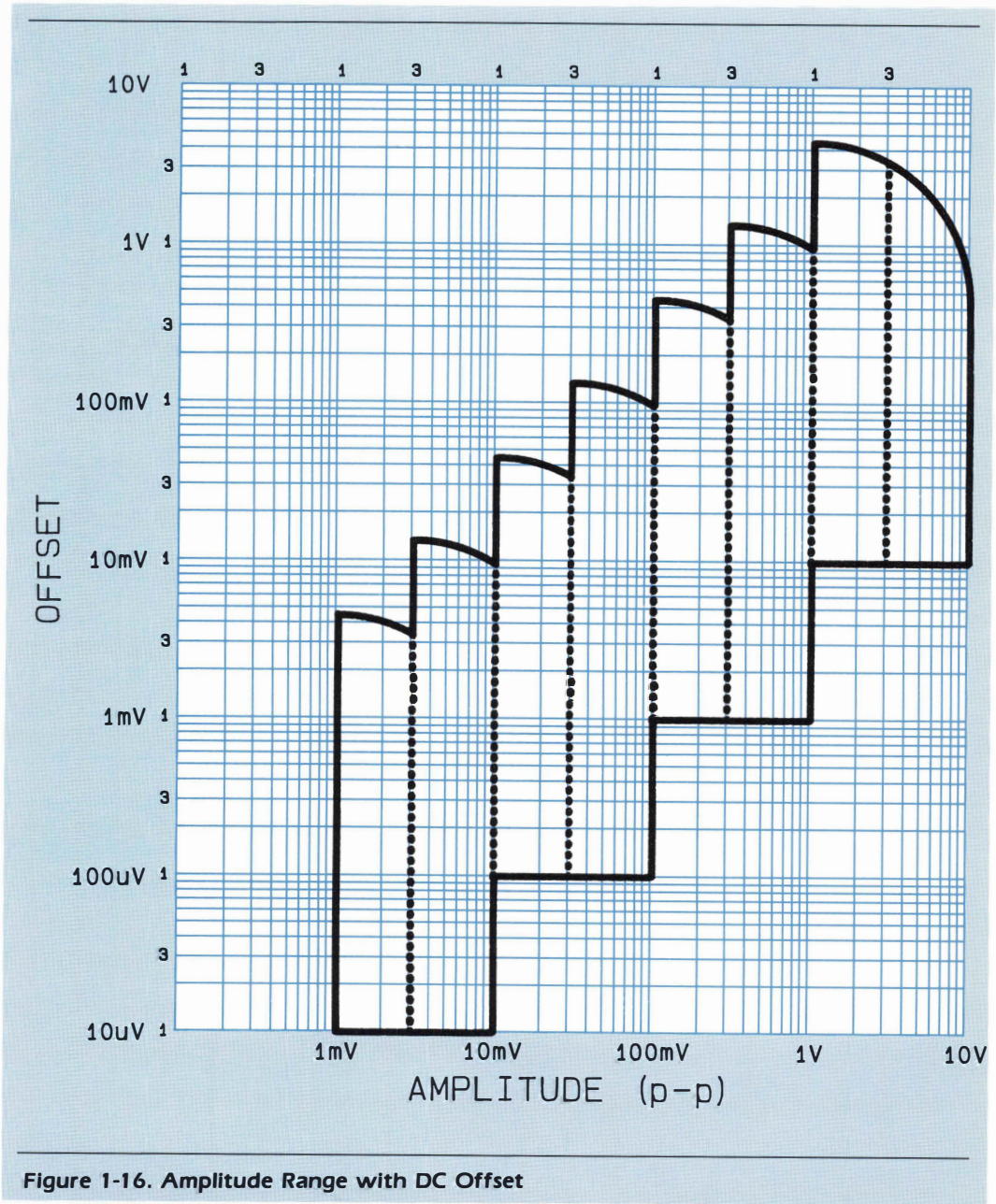


Figure 1-16. Amplitude Range with DC Offset

DC Offset

DC OFFSET

The DC OFFSET key enables display, entry, or modification of the dc offset of the channel selected with the CHAN key (see Figure 1-17). The indicator above the DC OFFSET key illuminates when a dc offset value is displayed. The displayed dc offset value is changed with the numeric keypad and VOLTS units key, or modified with the MODIFY controls. The maximum dc offset range is ±5 volts (±20 volts with the high voltage option enabled). The dc offset range is dependent upon amplitude, and selection of combined operation, internal modulation, and high voltage option. Figure 1-15 lists the maximum output of the HP 3326A. The output signal is momentarily set at zero volts if internal attenuator settings change.

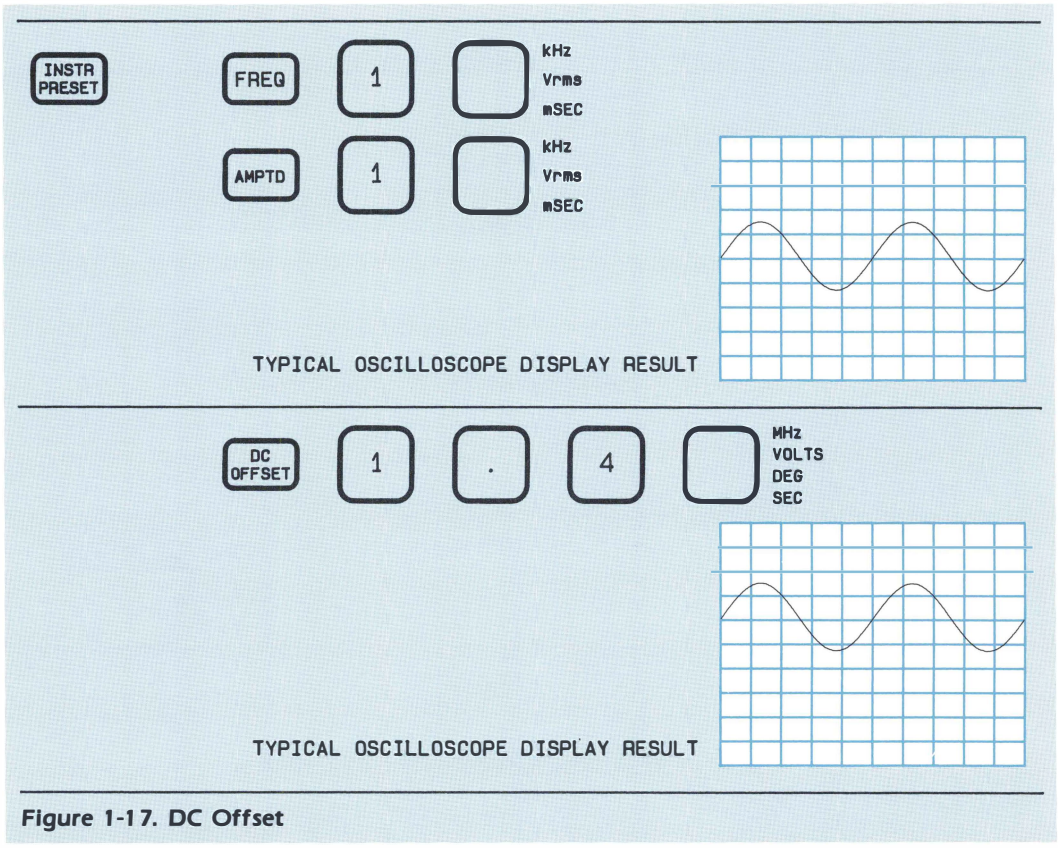


Figure 1-17. DC Offset

AC with DC Offset

The maximum dc offset is a function of the selected ac amplitude. The maximum amplitude for ac plus dc is ±5 volts peak (±20 with the high voltage option). DC offset versus amplitude (with combined operation, internal modulation, and high voltage option disabled) is illustrated in Figure 1-16. The maximum ac and dc outputs and maximum dc offsets for the HP 3326A are:

AC AMPLITUDE	MAXIMUM AC+DC	MAXIMUM DC OFFSET
1.0 to 10 Vpp	±5.0 V	±4.5 V
0.1 to 1.0 Vpp	±0.5 V	±0.45 V
10 to 100 mVpp	±50 mV	±45 mV
1 to 10 mVpp	±5 mV	±4.5 mV

DC Only

With the output FUNCTION set to DC, the output level is controlled by DC OFFSET entries. The maximum dc output is ±5 volts peak (±20 with the high voltage option).

Combined

For COMBINED operation with a sine wave, square wave, or OFF output FUNCTION selected, the dc offset is set to zero.

High Voltage Option

With the high voltage option enabled, the dc offset range is ±20 volts (ac + dc peak value or dc only). DC offset with the high voltage option is independent of the ac amplitude except that the combination of ac plus dc cannot exceed ± 20 volts.

Internal Modulation

With internal modulation, the channel B dc offset is disabled.

HP-IB Example

"OF3VO"

Phase

PHASE

The PHASE key enables display, entry, or modification of the phase of the channel selected with the CHAN key. The indicator above the PHASE key illuminates when a phase value is displayed. The displayed phase value is changed with the numeric keypad and DEG (DEGrees) units key, or modified with the MODIFY controls. The phase display range is ± 720 degrees with a resolution of 0.01 degrees. Phase values of ± 1440 degrees entered through the keypad are accepted and the value is displayed modulo 720. The effect of the phase offset is dependent upon selection of the operating mode. Figure 1-18 illustrates the effect of changing phase.

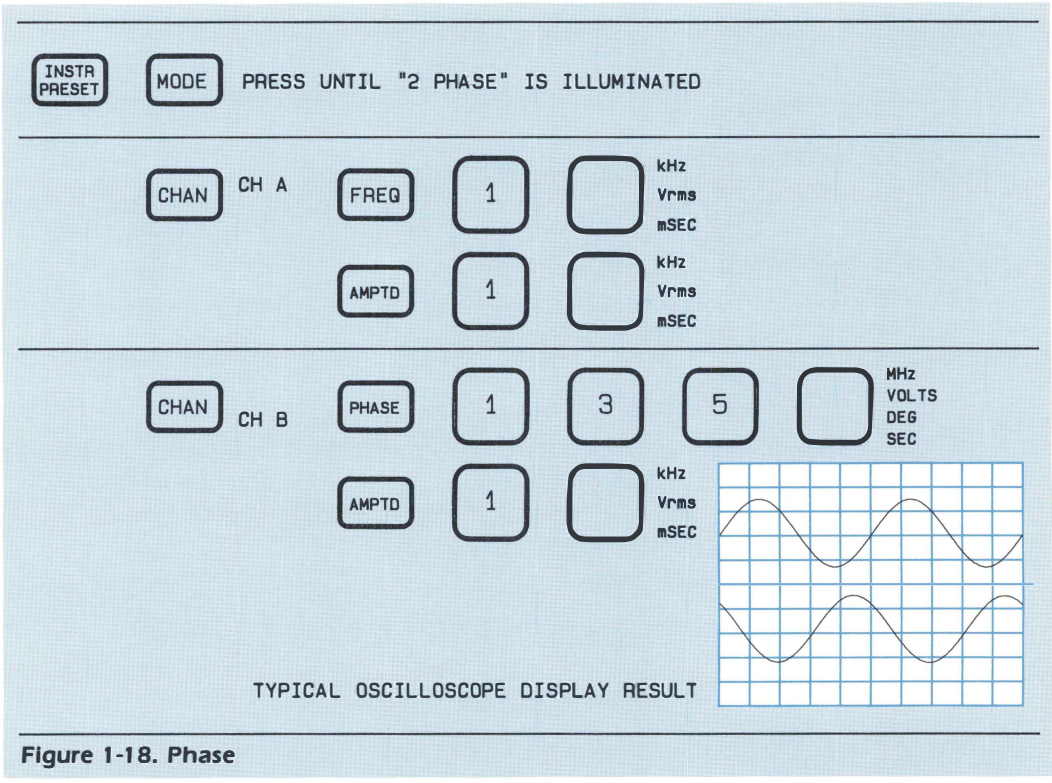


Figure 1-18. Phase

2 Channel Mode

Changing phase in the 2 CHANNEL mode changes the phase of a channel with respect to the initial waveform. The phase of channel A and B are independent.

2 Phase Mode

Without an external phase reference, a change in the phase of channel A is made with respect to the initial channel A waveform. With an external phase reference, a change in the phase of channel A is made with respect to the external reference. Channel B uses channel A as the phase reference, and a change to the channel B phase is made with respect to the current channel A waveform.

2 Tone Mode

Changing phase in the 2 TONE mode changes the phase of a channel with respect to the initial waveform. The phase of channel A and B are independent.

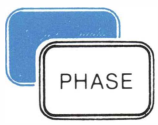
Pulse Mode

A change in the phase of channel A is made with respect to the initial channel A waveform. The channel B output is the complement of the channel A output. An attempt to display the channel B phase results in the display of the "Error 47 INTR" (INTeRrogate) message.

HP-IB Example

"PH32.05DEG"

Asgn Zero ϕ



The ASGN ZERO ϕ (ASsiGN ZERO phase) key assigns zero to the phase offset between channel A and B (or between channel A and an external phase reference) without changing the phase of the output waveforms. The ASGN ZERO ϕ key is selected by pressing the blue SHIFT key prior to the PHASE key. If channel A is selected, the channel A phase value is changed to zero. If channel B is selected, the phase offset value is summed modulo 720 and stored in an internal phase offset register. Subsequent assignments of zero phase sums the displayed phase value into the phase offset register. The stored phase offset value is recalled with the CLR ϕ OFS key. The ϕ OFS (phase offset) indicator illuminates when a phase offset value is stored.

HP-IB Example

"ZPH"

Clr ϕ Offset



The CLR ϕ OFS (CLeaR phase OFfSet) key restores the channel B phase offset value to the display without changing the phase of the output waveforms. If the current channel B phase value is nonzero, the phase offset is summed to the phase value modulo 720. The CLR ϕ OFS key is selected by pressing the blue SHIFT key prior to the DC OFFSET key. The CLR ϕ OFS key extinguishes the ϕ OFS indicator. Pressing the CLR ϕ OFS key with channel A selected displays the message "Error 120 P OF" (Phase OFfset).

HP-IB Example

"COF"

Duty Cycle (Pulse Width)



The DUTY CYCLE key enables display, entry, or modification of the duty cycle of the pulse mode channel A waveform. The DUTY CYCLE key is selected by pressing the blue SHIFT key prior to the FREQ key. The DUTY CYCLE indicator illuminates when the duty cycle value is displayed. After selection of the DUTY CYCLE key, the duty cycle value is changed with the numeric keypad and % units key, or modified with the MODIFY controls. The duty cycle range is from 1% to 99% of the period with a minimum pulse width of 20 nanoseconds. The resolution of the duty cycle is 0.01%. The duty cycle remains constant for changes in frequency provided the pulse width is greater than 20 nanoseconds. Figure 1-19 illustrates the effect on changes in duty cycle.

HP-IB Example

"25.05PC"

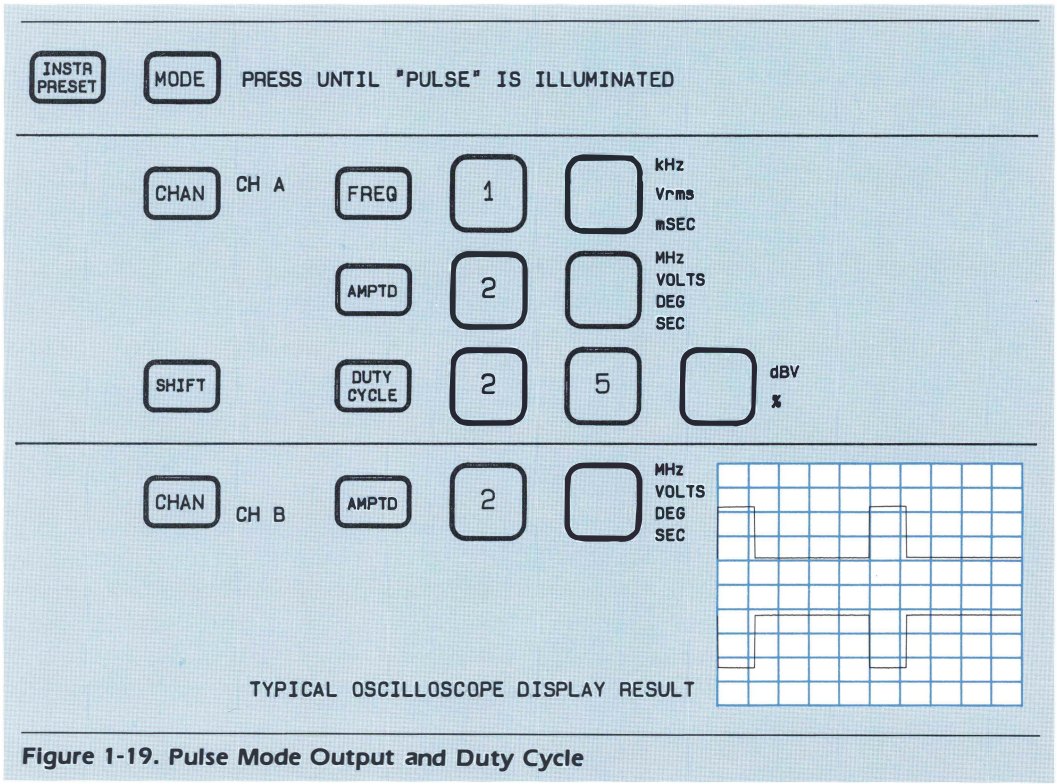
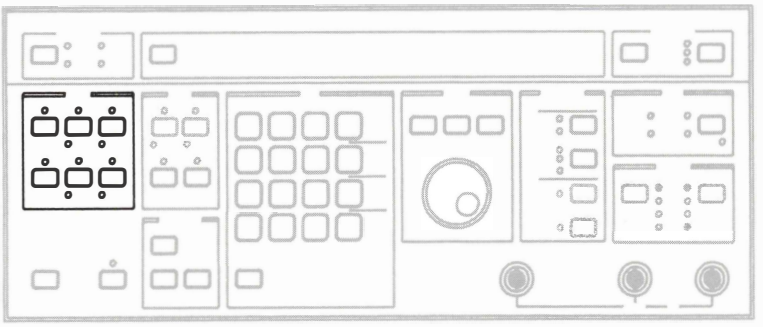


Figure 1-19. Pulse Mode Output and Duty Cycle

LINEAR FREQUENCY SWEEP



Linear sweeps are phase continuous over the full frequency range; that is, there are no phase discontinuities in the swept output waveform. Single or continuous (see Figure 1-20), and ramp or triangle (see Figure 1-21) linear sweeps are selectable. Linear sweep parameters are entered with the START FREQ (START FREQuency), STOP FREQ (STOP FREQuency), CNTR FREQ (CeNTeR FREQuency), SPAN, TIME, AND MKR→CF keys. The MKR FREQ (MarKeR FREQuency) key allows the rear panel TTL level MARKER OUT (MARKER OUTput) signal to be specified.

Single Sweep

SINGLE

The SINGLE key initiates a single linear sweep. The indicator above the SINGLE key illuminates when a single sweep is in progress. With a ramp sweep selected (i.e. TRIANGLE indicator extinguished), the SINGLE key initiates a sweep from the start frequency to the stop frequency over the specified sweep time. Upon reaching the stop frequency, the frequency is quickly changed to the start frequency. With a TRIANGLE sweep selected, the SINGLE key initiates a sweep from the start frequency to the stop frequency over the specified sweep time. The stop frequency is maintained until the SINGLE key is pressed. Pressing the SINGLE key initiates another sweep from the stop frequency to the start frequency.

HP-IB Example:

"SS"

Continuous Sweep

CONT

The CONT (CONTinuous) key initiates a continuous linear sweep. The indicator above the CONT key illuminates when a continuous sweep is in progress. With a ramp sweep selected (i.e. TRIANGLE indicator extinguished), the CONT key initiates a repetitive sweep from the start frequency to the stop frequency over the specified sweep time. Upon reaching the stop frequency, the frequency is quickly changed to the start frequency in preparation for the next sweep. With a TRIANGLE sweep selected, the CONT key initiates a repetitive sweep from the start frequency to the stop frequency and back to the start frequency. Each sweep (from either the start frequency to stop frequency, or from stop frequency to start frequency) is over the specified sweep time.

HP-IB Example:

"SC"

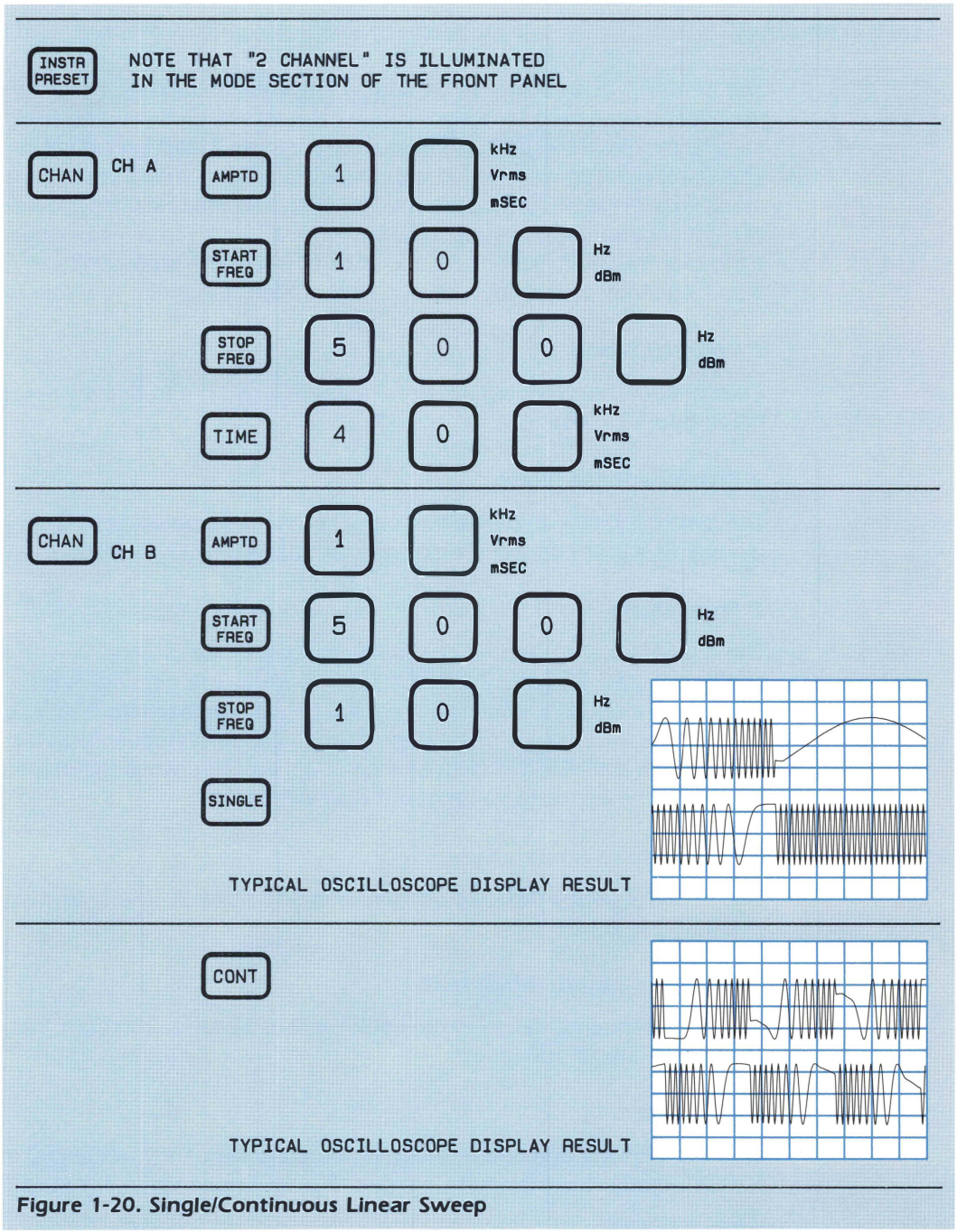


Figure 1-20. Single/Continuous Linear Sweep

Start Frequency

START FREQ

The START FREQ (START FREQuency) key enables display, entry, or modification of the linear sweep start frequency of the channel selected with the CHAN key. The indicator above the START FREQ key illuminates when a start frequency value is displayed. The displayed frequency value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz. Start frequency values may be greater than the stop frequency values for a sweep from a high frequency to a low frequency.

2 Channel Mode

Each channel start frequency is set independently. The frequency range of each channel is 0 to 13 MHz.

2 Phase or Pulse Mode

The start frequency of both channels is set to the same value by a change in start frequency of either channel. The frequency range is 0 to 13 MHz.

2 Tone Mode

The channel B start frequency tracks changes to the channel A start frequency. The channel A start frequency range is 0 to 13 MHz. The channel B start frequency can have up to a 100 kHz offset from channel A with a maximum frequency of 13.1 MHz. If a channel A frequency change forces the channel B frequency to less than zero, the channel B frequency is displayed as a negative value while the channel B output frequency is the absolute value of the displayed value.

Internal Phase Modulation

The start frequency range of channel A is 0 to 13 MHz. The start frequency range of channel B is 0 to 5 kHz.

Internal Amplitude Modulation

The start frequency range of channel A is 0 to 13 MHz. The start frequency range of channel B is 0 to 100 kHz.

HV Option

With the high voltage option enabled, the start frequency range is 0 to 1 MHz. In the 2 TONE mode, the maximum channel B start frequency is 1.1 MHz.

HP-IB Example:

"ST1.512525KHZ"

Stop Frequency



The STOP FREQ (STOP FREQuency) key enables display, entry, or modification of the linear sweep stop frequency of the channel selected with the CHAN key. The indicator above the STOP FREQ key illuminates when a stop frequency value is displayed. The displayed frequency value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz.

2 Channel Mode

Each channel stop frequency is set independently. The frequency range of each channel is 0 to 13 MHz.

2 Phase or Pulse Mode

The stop frequency of both channels is set to the same value by a change in stop frequency of either channel. The frequency range is 0 to 13 MHz.

2 Tone Mode

The channel B stop frequency tracks changes to the channel A stop frequency. The stop frequency range of channel A is 0 to 13 MHz. The channel B stop frequency can have up to a 100 kHz offset from channel A, with a maximum frequency of 13.1 MHz. If a channel A frequency change forces the channel B frequency to less than zero, the channel B frequency is changed to a value equal to the channel A frequency plus the absolute value of the offset.

Internal Phase Modulation

The stop frequency range of channel A is 0 to 13 MHz. The stop frequency range of channel B is 0 to 5 kHz.

Internal Amplitude Modulation

The stop frequency range of channel A is 0 to 13 MHz. The stop frequency range of channel B is 0 to 100 kHz.

HV Option

With the high voltage option enabled, the stop frequency range is 0 to 1 MHz. In the 2 TONE mode, the maximum channel B frequency is 1.1 MHz.

HP-IB Example:

"SP7.512525KHZ"

Time

TIME

The TIME key enables display, entry, or modification of the linear sweep time for both channels. The indicator above the TIME key illuminates when a time value is displayed. The displayed time value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The SEC and mSEC units keys end entry of numeric values. The time range is 5 milliseconds to 1000 seconds, with a resolution of 1 millisecond.

HP-IB Example:

"STIM25MS"

Marker Frequency

MKR FREQ

The MKR FREQ (MarKeR FREQuency) key enables display, entry, or modification of the marker frequency of the channel selected with the CHAN key. The indicator above the MKR FREQ key illuminates when the marker frequency value is displayed. The displayed frequency value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz. Only one marker is available.

NOTE

When different start or stop frequencies are entered for each channel, selecting alternate channels can have the apparent effect of changing the marker frequency. Although the marker occurs at the same time, each channel may have a unique frequency at that time.

For a marker signal to be generated, the MKR FREQ must be within 3 milliseconds of the start or stop frequency. The following equation may be used to determine the approximate marker offset from the start or stop frequency:

$$\text{MARKER OFFSET} \geq \frac{0.003 \times \text{SPAN}}{\text{SWEEP TIME}}$$

The marker value is accepted and the message "Error 24 RNGE" is displayed if the marker value is outside the sweep frequency span. The Z-BLANK output is coincident with the start and stop frequencies and may be used for the marker of these frequencies.

HP-IB Example:

"MF5.512525KHZ"

Triangle



The TRIANGLE key selects either a triangle or ramp sweep. The TRIANGLE key is selected by pressing the blue SHIFT key prior to the MKR FREQ key. The TRIANGLE indicator is illuminated when a triangle sweep is selected, and extinguished when a ramp sweep is selected.

HP-IB Examples:

"SM1"	"SM2"
or	or
"SM RAMP"	"SM TRGL"

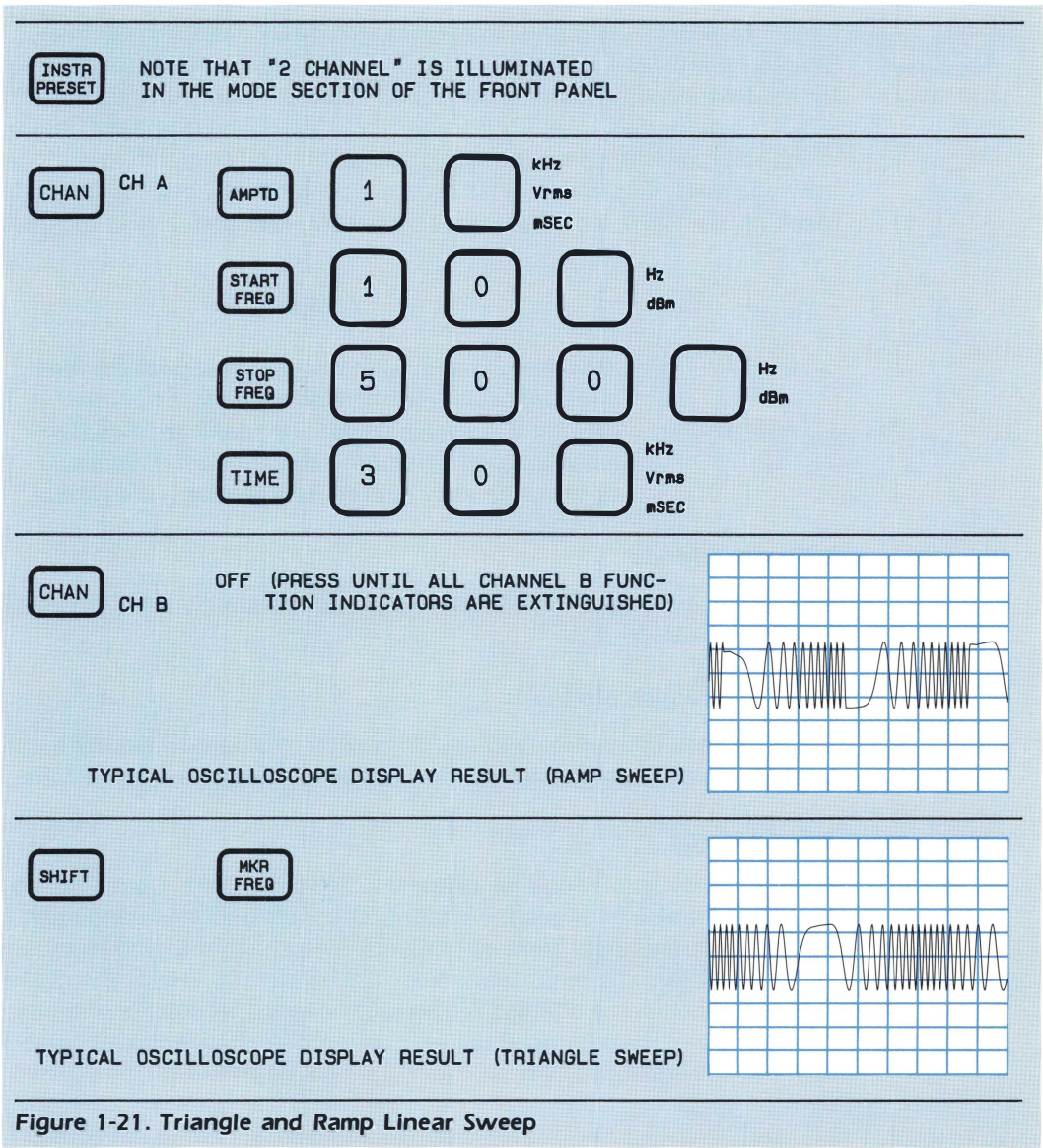


Figure 1-21. Triangle and Ramp Linear Sweep

Reset Sweep



The RESET SWP (RESET SWeeP) key resets the sweep circuits to the start of the sweep. During reset, the HP 3326A also checks the sweep limits.

HP-IB Example:

"SRE"

Span



The SPAN key enables display, entry, or modification of the total linear sweep frequency span of the channel selected with the CHAN key. The SPAN key is available by pressing the blue SHIFT key prior to pressing the STOP FREQ (STOP FREQuency) key. The SPAN key, with the CNTR FREQ (CeNTeR FREQuency) key, provides an alternate entry for the frequency sweep start and stop values. The SPAN indicator illuminates when SPAN is selected and the SPAN value is displayed. The displayed frequency span value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz.

NOTE

Frequency spans must be consistent with the operating limits and the value entered for the center frequency. Excessive frequency spans are symmetrically reduced around the current center frequency to bring the start or stop frequencies within limits.

2 Channel Mode

The frequency span of each channel is set independently. The frequency range of each channel is 0 to 13 MHz.

2 Phase or Pulse Mode

The frequency span of both channels is set to the same value by a change in the frequency span of either channel. The frequency range is 0 to 13 MHz.

2 Tone Mode

The frequency span range for channel A is 0 to 13 MHz. Changing the channel A frequency span also changes the channel B center frequency and span to maintain the current start and stop frequency offsets. The channel B frequency span may be set so that the start and stop frequencies are within 100 kHz of the channel A start and stop frequencies. If a channel A frequency change forces the channel B frequency to less than zero, the channel B output frequency is changed to the absolute value of the channel B frequency.

NOTE

The difference (offset) between the channel A and B frequencies will normally change during a sweep to maintain the offsets entered for the sweep start and stop frequencies. If a constant offset is desired, there must be a constant offset between the start and stop frequency values for channel A and B.

HV Option

With the high voltage option enabled, the maximum frequency span is 1 MHz. In the 2 TONE mode, the maximum channel B frequency span is 1.1 MHz.

HP-IB Example:

"SPAN5.512525KHZ"

Center Frequency



The CNTR FREQ (CeNTeR FREQuency) key enables display, entry, or modification of the linear sweep center frequency of the channel selected with the CHAN key. The CNTR FREQ key is available by pressing the blue SHIFT key prior to the START FREQ key. The CNTR FREQ key, along with the SPAN key, provides an alternate entry of the frequency sweep start and stop values.

The displayed frequency value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The MHz, kHz, and Hz units allow convenient entry of frequency values. The frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz. If the center frequency causes the sweep start or stop frequency to exceed the HP 3326A limits, the frequency span is reduced.

2 Channel Mode

The center frequency of each channel is set independently. The frequency range of each channel is 0 to 13 MHz.

2 Phase or Pulse Mode

The center frequency of both channels is set to the same value by a change in center frequency of either channel. The frequency range is 0 to 13 MHz.

2 Tone Mode

The channel A center frequency has the range of 0 to 13 MHz. The start and stop frequencies of channel B tracks changes to the channel A start and stop frequencies to maintain the current offset. The channel B center frequency can have up to a 100 kHz offset from channel A providing the channel B start and stop frequencies are within 100 kHz of the channel A start and stop frequencies.

HP-IB Example:

"CF5.512525KHZ"

Marker to Center Frequency



The MKR → CF (MarKeR to Center Frequency) key centers the sweep band on the frequency set for the marker. The MKR → CF key is selected by pressing the blue SHIFT key prior to the CONT key. If either the sweep start or stop frequency exceeds the frequency limits, the frequency band is reduced.

2 Channel Mode

The center frequency of each channel is set independently. The frequency range of each channel is 0 to 13 MHz.

2 Phase or Pulse Mode

The center frequency of both channels is set to the same value by a change in the center frequency of either channel. The frequency range is 0 to 13 MHz.

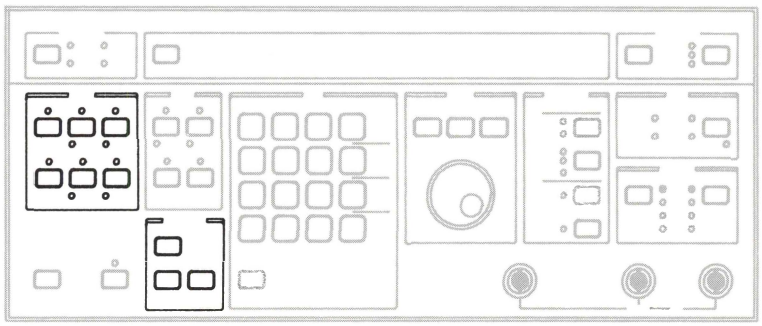
2 Tone Mode

The channel A center frequency has the range of 0 to 13 MHz. The start and stop frequencies of channel B tracks changes to the channel A start and stop frequencies to maintain the current offset. The channel B center frequency can have up to a 100 kHz offset from channel A providing the channel B start and stop frequencies are within 100 kHz of the channel A start and stop frequencies.

HP-IB Example:

"CFM"

DISCRETE FREQUENCY SWEEP



During a discrete frequency sweep, the HP 3326A sequences through the discrete frequency sweep elements (channel A and B frequencies, and dwell time) stored in non-volatile memory with the SAVE DISCRETE key (see Figure 1-22). Discrete frequency sweep element frequencies are entered with the FREQ (FREQuency) key, and dwell times are entered with the TIME key. The HP 3326A always sequences through the discrete frequency sweep elements from element 00 to the last element entered. With SINGLE sweep selected, the HP 3326A sequences through the elements each time the SINGLE key is pressed. With CONT sweep selected, the HP 3326A sequences through the elements continuously. The message "Error 110 DSWP" (Discrete frequency SWeeP) is displayed if no discrete frequency sweep elements are stored in memory. Selecting TRIANGLE for a discrete frequency sweep cancels the discrete frequency sweep and selects a linear sweep.

Discrete



The DISCRETE key enables and disables discrete frequency sweeps. The DISCRETE key is available by pressing the blue SHIFT key prior to pressing the TIME key. The DISCRETE indicator illuminates when discrete frequency sweeps are enabled.

HP-IB Examples:

"SM3"
or
"SM DSCR"

Recall Discrete



The RCL DISCRETE (ReCaLl DISCRETE) key followed by a discrete element number replaces the channel A and B frequency values and time values with the values stored for a discrete frequency sweep element. The RCL DISCRETE key is available by pressing the blue SHIFT key prior to pressing the RECALL key. Valid discrete elements numbers range from 00 to 62. Recalling a null discrete frequency sweep element number displays the message "Error 20 RNGE."

HP-IB Example:

"DRCL02"

Save Discrete



SAVE DISCRETE

The SAVE DISCRETE key followed by a discrete frequency sweep element number stores the current channel A and B frequency values and dwell time value in nonvolatile memory. The SAVE DISCRETE key is available by pressing the blue SHIFT key prior to pressing the SAVE key. Valid discrete frequency sweep element numbers range from 00 to 62. When initially entering discrete frequency sweep elements, the element numbers must start with 00 and be sequential. Existing discrete frequency elements may be recalled, edited, and replaced in any order. Storing a discrete frequency sweep element with a nonsequential number, or using a number greater than 62 displays the message "Error 23 RNGE" (RaNGE). The message "Error 117 DSWP" (Discrete frequency SWeeP) is displayed if a discrete frequency element is entered after the mode is changed.

Discrete frequency sweep element storage uses the same nonvolatile memory as the SAVE key stores. Discrete sweep frequency storage memory is assigned by the HP 3326A. Discrete frequency sweep elements are stored in the following memory registers:

DISCRETE FREQUENCY ELEMENT NUMBER	MEMORY REGISTER
00 - 06	9
07 - 13	8
14 - 20	7
21 - 27	6
28 - 34	5
35 - 41	4
42 - 48	3
49 - 55	2
56 - 62	1

Saving an operating state in a memory register that interrupts the contiguous memory used to save discrete frequency sweep elements displays the "Error 23 RNGE" (RaNGE) message. Saving an operating state in the lowest memory register occupied by discrete frequency sweep elements reclaims that memory register for operating state storage.

HP-IB Example:

"DSAV02"

Single Sweep



The SINGLE key initiates a single discrete frequency sweep. The indicator above the SINGLE key illuminates when a single sweep is in progress. The SINGLE key initiates a sweep from the discrete frequency sweep element 00 to the last entered element. During a sweep, the SINGLE key causes the HP 3326A to step from the current discrete frequency sweep element to the next discrete frequency sweep element.

HP-IB Example:

"SS"

Continuous Sweep



The CONT (continuous) key initiates a continuous discrete frequency sweep. The indicator above the CONT key illuminates when a continuous sweep is in progress.

HP-IB Example:

"SC"

Clear Discrete



The CLR DISCRETE (CLeaR DISCRETE) key replaces the discrete frequency sweep elements stored in nonvolatile memory with the preset operating state. The CLR DISCRETE key is available by pressing the blue SHIFT key prior to the green INSTR PRESET key.

HP-IB Example:

"DRST"

Time

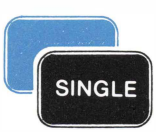


The TIME key enables display, entry, or modification of the discrete frequency sweep element dwell time for both channels. After selection of the TIME key, the time value is changed with the numeric keypad and units keys, or modified with the MODIFY controls. The SEC and mSEC units keys end entry of numeric values. The time range is from 5 milliseconds to 1000 seconds with a resolution of 1 millisecond.

HP-IB Example:

"STIM25MS"

Reset Sweep



The RESET SWP (reset sweep) key resets the sweep circuits to the start of the sweep. For triggered operation, manually resetting the sweep circuits before the trigger minimizes the delay between the trigger and start of sweep.

HP-IB Example:

"SRE"

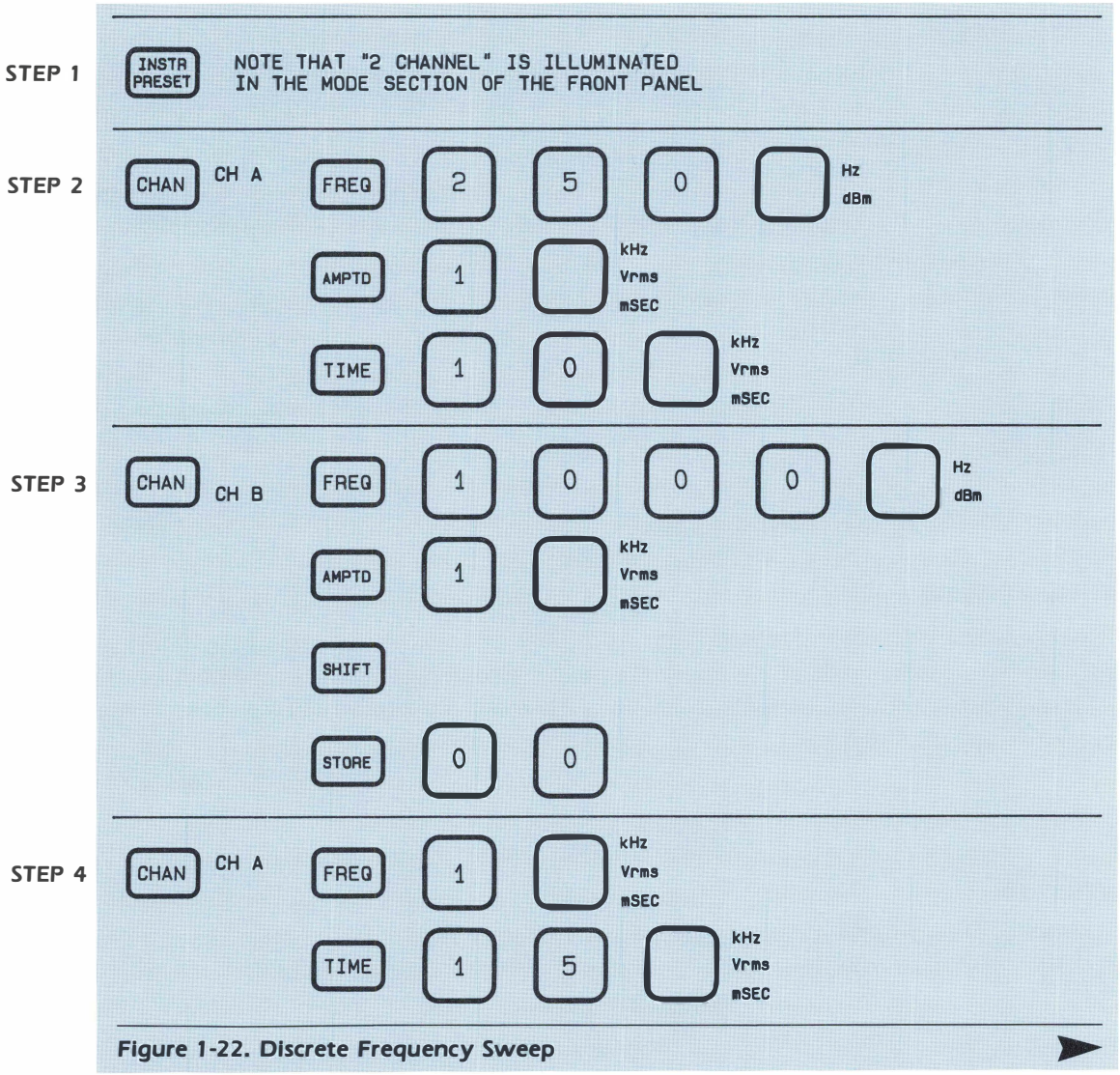


Figure 1-22. Discrete Frequency Sweep

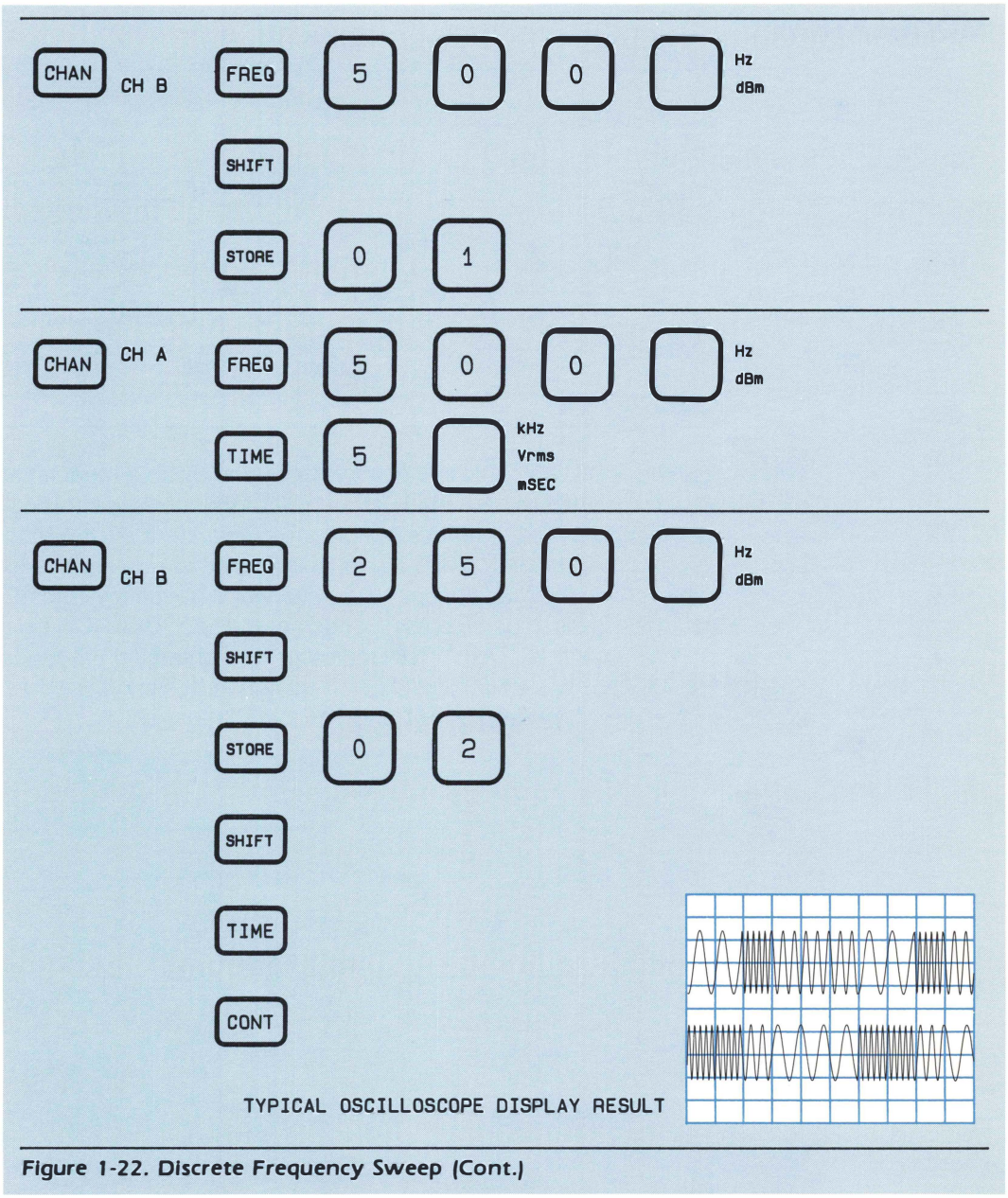
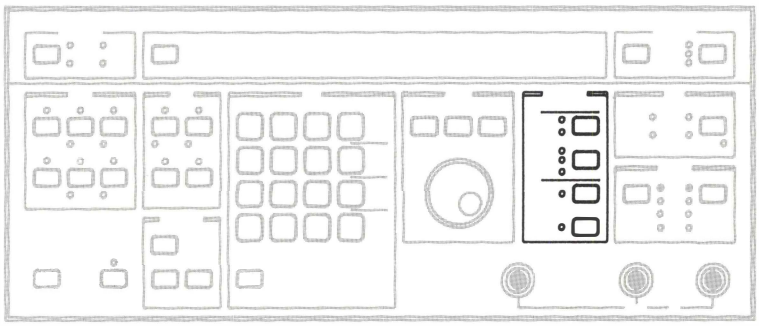


Figure 1-22. Discrete Frequency Sweep (Cont.)

MODULATION



The keys in the MODULATION key block enable and disable modulation. Each time a modulation key is pressed, the modulation indicators sequence through the available selections. Available modulation selections are dependent on the mode. Figure 1-24 lists the types of modulation available for the operating modes. If a modulation type is unavailable, check the mode of operation, channel B frequency, and COMBINED operation. Modulation is disabled by pressing each of the MODULATION selection keys and extinguishing all of the MODULATION indicators, by changing the mode, or by presetting the HP 3326A. Figure 1-23 illustrates modulation definition. Figures 1-25 and 1-26 illustrates the effect of internal AM and PM modulation.

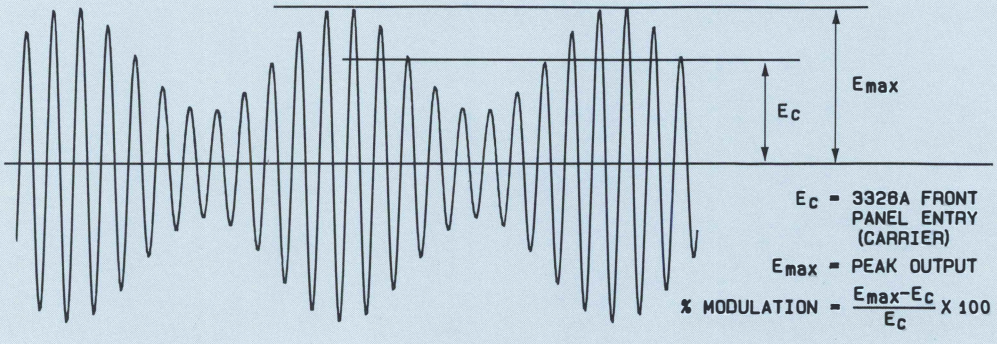
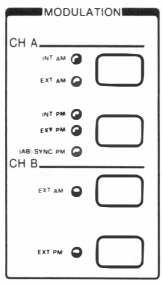


Figure 1-23. Modulation Definition

		2 CHANNEL	2 PHASE	2 TONE	PULSE
CHANNEL A	AM	INT OR EXT	EXT	EXT	EXT
	PM	INT OR EXT	SYNC	SYNC	SYNC
CHANNEL B	AM	EXT	EXT	EXT	EXT
	PM	EXT	SYNC AND EXT	SYNC AND EXT	SYNC AND EXT

Figure 1-24. Available Modulation for HP 3326A Modes

Internal AM/%AM



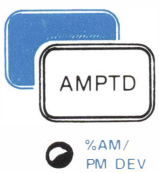
Internal amplitude modulation is enabled in the 2 CHANNEL mode when the channel A INT AM (INternal Amplitude Modulation) indicator is illuminated. Internal amplitude modulation uses the channel B synthesizer as the modulation source for channel A, thus only the channel A output is active. For internal amplitude modulation, 100 kHz is the maximum channel B frequency. Internal amplitude modulation limits the values entered for the channel A amplitude to 50% (6.02 dB) of the normal range.

When internal modulation is selected, the channel B high voltage option is disabled. If internal modulation cannot be selected (i.e. the INT AM indicator does not illuminate), check that the 2 CHANNEL mode is selected, COMBINED operation is disabled, and the channel B frequency is below 100 kHz.

HP-IB Example:

"AIA1"
or
"AIA ON"

Percent AM



The %AM/PM DEV (percent Amplitude Modulation/Phase Modulation DEViation) key enables display, entry, or modification of the modulation percentage. The %AM/PM DEV key is selected by pressing the blue SHIFT key prior to the AMPTD key. The %AM/PM DEV indicator illuminates when the modulation value is displayed. After selection of the %AM/PM DEV key, the modulation value is entered or modified with the numeric keypad and % units key, or modified with the MODIFY controls. The modulation value ranges from 0 to 100% with 0.1% resolution. With 0% amplitude modulation, the channel A output level is equal to the amplitude entered for the AMPTD key. The modulation value is used for both AM and PM. If the displayed modulation value is in degrees, pressing the % units key converts the displayed value to percent. Similarly, if the displayed value is in degrees, pressing the DEG units key converts the displayed value to degrees.

HP-IB Example:

"ML30.5PC"

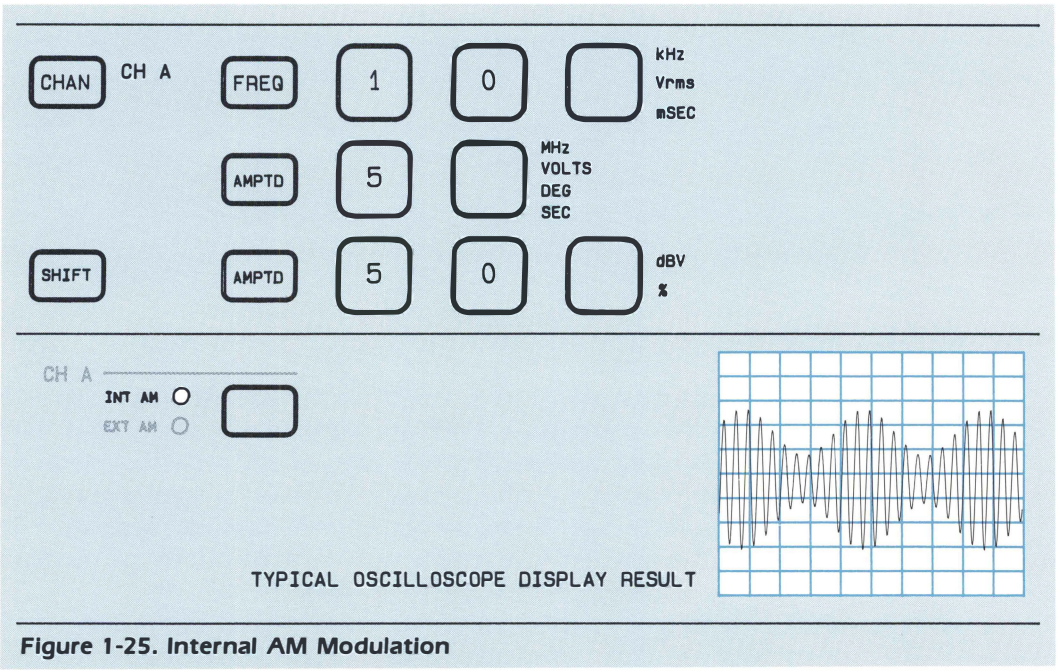


Figure 1-25. Internal AM Modulation

Internal PM/PM DEV



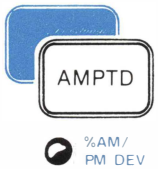
Internal phase modulation is enabled in the 2 CHANNEL mode when the channel A INT PM (internal Phase Modulation) indicator is illuminated (see Figure 1-26). Internal phase modulation uses the channel B synthesizer as the modulation source for channel A. Thus, only the channel A output is active. For internal phase modulation, 5 kHz is the maximum channel B frequency.

When internal modulation is selected, the channel B high voltage option is disabled. If internal modulation cannot be selected (i.e. the INT PM indicator does not illuminate), check that the 2 CHANNEL mode is selected, COMBINED operation is disabled, and the channel B frequency is below 5 kHz.

HP-IB Example:

"AIP1"
or
"AIP ON"

PM Deviation



The %AM/PM DEV (percent Amplitude Modulation/Phase Modulation DEViation) key enables display, entry, or modification of the phase modulation deviation. The %AM/PM DEV key is selected by pressing the blue SHIFT key prior to the AMPTD key. The %AM/PM DEV indicator illuminates when the phase modulation deviation value is displayed. After selection of the %AM/PM DEV key, the phase modulation deviation is entered or modified with the numeric keypad and DEG units key, or modified with the MODIFY controls. The phase modulation deviation ranges from 0 to 360° with 0.01° resolution. The modulation value is used for both AM and PM. If the displayed modulation value is in degrees, pressing the % units key converts the displayed value to percent. Similarly, if the displayed value is in degrees, pressing the DEG units key converts the displayed value to degrees.

HP-IB Example:

"ML45DEG"

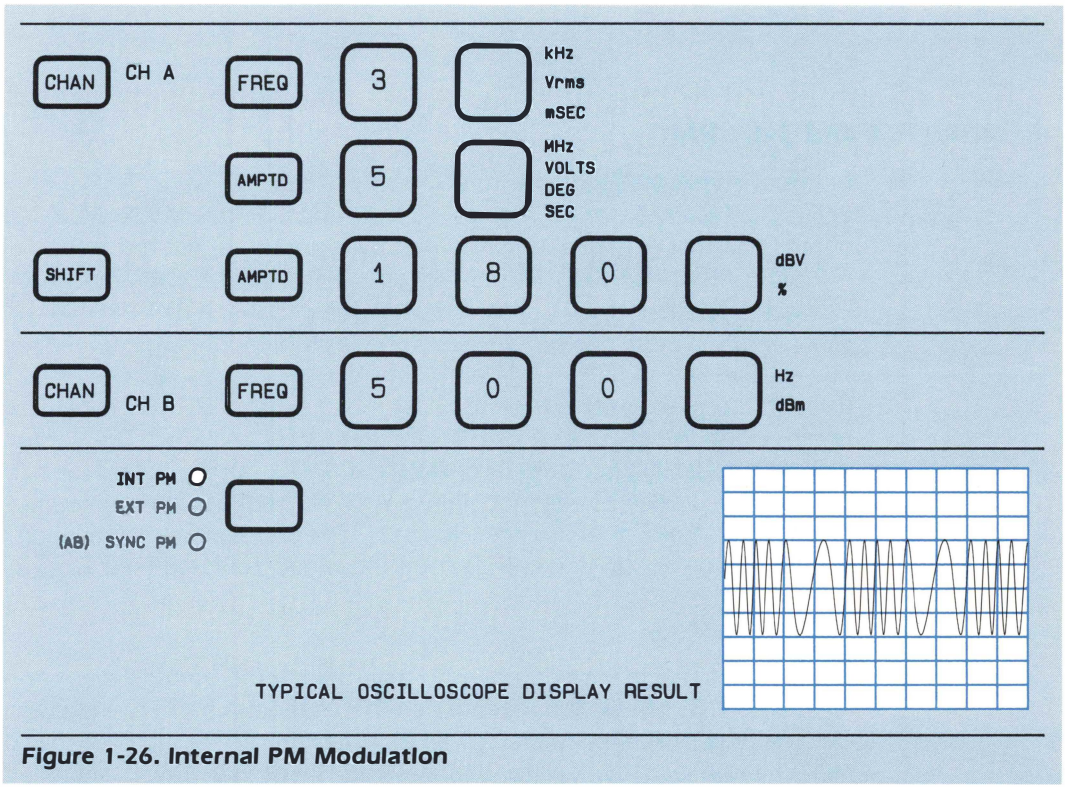
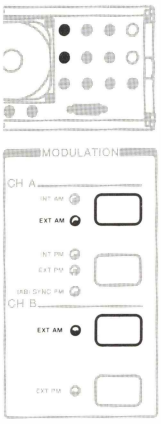


Figure 1-26. Internal PM Modulation

External AM



Either channel is amplitude modulated by an external source through the rear panel A-AMPTD MOD IN (channel A AMPliTuDe MODulation INput) or B-AMPTD MOD IN (channel B AMPliTuDe MODulation INput) connector when the respective channel EXT AM (EXTernal Amplitude Modulation) indicator is illuminated. The voltage range for the A-AMPTD MOD IN or B-AMPTD MOD IN connector is ±1.0 volt. A 2 volt peak-to-peak input results in 100% modulation. A 0 volt input results in an output equal to the amplitude entered for the AMPTD key. For channel A, a −1 volt input results in a minimum level. For channel B, a +1 volt input results in a minimum level. The maximum amplitude modulation frequency into the HP 3326A is 100 kHz. Amplitude modulation limits the values entered for the channel A amplitude to 50% (6.02 dB) of the normal range.

HP-IB Example:

"AEA1"
or
"AEA ON"
"BEA1"
or
"BEA ON"

External PM and Sync PM



External phase modulation is enabled when the EXT PM (EXTernal Phase Modulation) or (AB) SYNC PM (channel A and B SYNChronous Phase Modulation) indicator is illuminated. Channel A is phase modulated by an external source through the rear panel A-PHASE MOD IN/SYNC PM IN (channel A PHASE MODulation INput/SYNChronous Phase Modulation INput) connector when the channel A EXT PM or (AB) SYNC PM indicator is illuminated. For synchronous phase modulation, channel B phase is held constant relative to the channel A phase. Channel B is phase modulated by an external source through the rear panel B-PHASE MOD IN (channel B PHASE MODulation INput) connector when the channel B EXT PM indicator is illuminated. The voltage range for the A-PHASE MOD IN/SYNC PM IN or B-PHASE MOD IN connector is ±1.0 volt which corresponds to ±360° phase modulation. A 0 volt input results in an output with 0° modulation. The maximum frequency into the HP 3326A for phase modulation is 5 kHz. Phase modulation selection is dependent on the mode selected (see Figure 1-23).

2 Channel Mode

Channel A is phase modulated by an external source through the rear panel A-PHASE MOD IN/SYNC PM IN connector when the channel A EXT PM indicator is illuminated. Channel B is phase modulated by an external source through the rear panel B-PHASE MOD IN connector when the channel B EXT PM indicator is illuminated.

2 Phase, 2 Tone, or Pulse Mode

Both channels are synchronously phase modulated by an external source through the rear panel A-PHASE MOD IN/SYNC PM IN connector when the (AB) SYNC PM indicator is illuminated. Channel B is also phase modulated by an external source through the rear panel B-PHASE MOD IN connector when the channel B EXT PM indicator is illuminated.

HP-IB Example:

"AEP1"
or
"AEP ON"
"BEP1"
or
"BEP ON"
"SPE1"
or
"SPE ON"

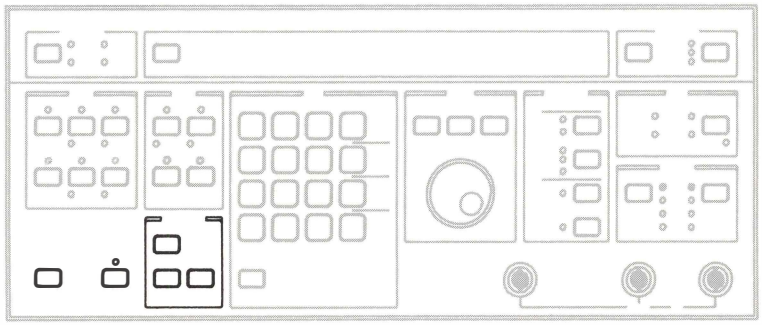
Disabling Modulation

Modulation is disabled by pressing the MODULATION selection keys corresponding to an illuminated indicator until all the indicators are extinguished. Modulation is also disabled by changing the mode with the MODE key or presetting the HP 3326A.

HP-IB Example:

"NOM"

SAVING/RECALLING AN INSTRUMENT STATE, AND MEMORY OPERATIONS



Save

SAVE

The SAVE key, followed by a digit from 0 to 9, saves the current operating state in nonvolatile memory. The digit following the SAVE key specifies the memory register for storing the operating state. If two operating states are saved in the same memory register, the operating state saved first is erased. Although 0 is a valid entry for a memory register, the contents of this memory register are replaced with the current operating state when power is removed from the HP 3326A.

Saving an operating state in a memory register that interrupts contiguous memory used by discrete frequency sweep elements displays the "Error 23 RNGE" (RaNGE) message. Saving an operating state in the lowest memory register occupied by discrete frequency sweep elements reclaims that memory register for operating state storage.

HP-IB Example:

"SAV2"

Recall

RECALL

The RECALL key, followed by a digit from 0 to 9, recalls an operating state saved in nonvolatile memory. The digits 0 to 9 select the memory register for the recall operation. Recalling a memory register with discrete frequency sweep elements generates the "Error 20 RNGE" (RaNGE) error message.

HP-IB Example:

"RCL3"

Power Down State



Memory register 0 contains the last operating state prior to removing power. The last operating state established prior to removing power is restored by pressing the RECALL key followed by the digit 0.

Through the use of the internal SAVE switch, the setup state stored in register 0 can be selected as the turn on state. Setting of internal switches must be done by qualified service personnel. The location and settings of the SAVE switch are described in the HP 3326A Service Manual.

Memory Clear



Applying power to the HP 3326A with the blue SHIFT key pressed replaces the contents of all nonvolatile memory registers with the INSTR PRESET state. All saved operating states and discrete frequency sweep elements are replaced with the INSTR PRESET state.

Recall Discrete



The RCL DISCRETE (ReCaLl DISCRETE) key followed by a discrete frequency sweep element number replaces the channel A and B frequency values and time value with the values stored for the discrete frequency sweep element. The RCL DISCRETE key is available by pressing the blue SHIFT key prior to pressing the RECALL key. Valid discrete frequency sweep elements numbers range from 00 to 62. Recalling a null discrete frequency sweep element displays the message "Error 20 RNGE" (RaNGE).

HP-IB Example:

"DRCL02"

Save Discrete



The SAVE DISCRETE key followed by a discrete frequency sweep element number stores the current channel A and B frequency values and dwell time value in nonvolatile memory. The SAVE DISCRETE key is available by pressing the blue SHIFT key prior to pressing the SAVE key. Valid discrete frequency sweep element numbers range from 00 to 62. When initially entering discrete frequency sweep elements, the element numbers must start with 00 and be sequential. Existing discrete frequency elements may be recalled, edited, and replaced in any order. Storing a discrete frequency sweep element with a nonsequential number, or using a number greater than 62 displays the message "Error 23 RNGE" (RaNGE). The message "Error 117 DSWP" (Discrete frequency SWeeP) is displayed if a discrete frequency element is entered after the mode is changed.

Discrete frequency sweep element storage uses the same nonvolatile memory as a SAVE operation starting with memory register 9. Discrete frequency sweep elements are stored in the following memory registers:

DISCRETE FREQUENCY ELEMENT NUMBER	MEMORY REGISTER
00 - 06	9
07 - 13	8
14 - 20	7
21 - 27	6
28 - 34	5
35 - 41	4
42 - 48	3
49 - 55	2
56 - 62	1

Saving an operating state in a memory register that interrupts the contiguous memory used to save discrete frequency sweep elements displays the "Error 23 RNGE" (RaNGE) message. Saving an operating state in the lowest memory register occupied by discrete frequency sweep elements reclaims that memory register for operating state storage.

HP-IB Example:

"DSAV03"

Clear Discrete



The CLR DISCRETE (CLeaR DISCRETE) key erases all discrete frequency sweep elements stored in nonvolatile memory and replaces the states with the preset state. The CLR DISCRETE key is available by pressing the blue SHIFT key prior to the green INSTR PRESET key.

HP-IB Example:

"DCLR"

Instrument Preset

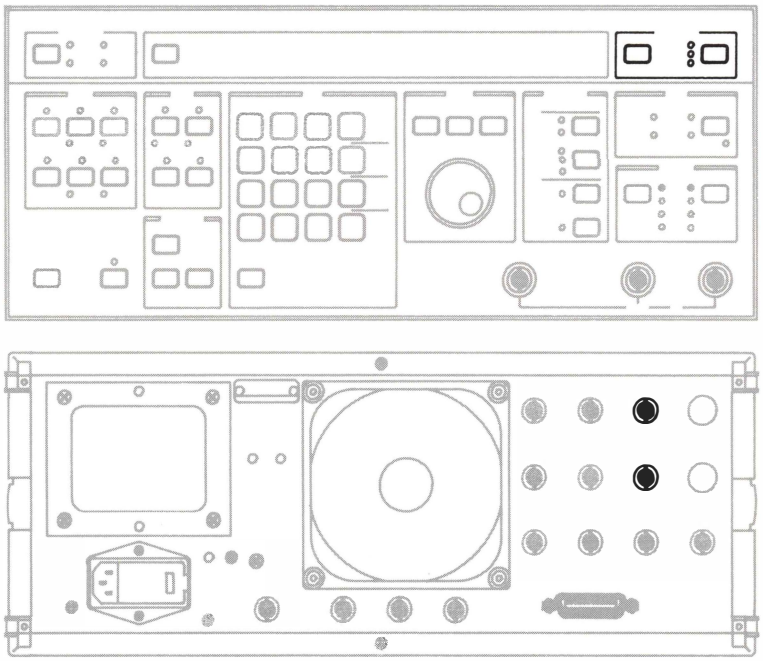


The HP 3326A is restored to the preset state by pressing the green INSTR PRESET (INSTRument PRESET) key in the INSTR STATE (INSTRument STATE) key group. INSTR PRESET provides a convenient state for establishing an instrument setup, and does not destroy any instrument states stored in nonvolatile memory. The preset state is listed in Figure 1-1.

HP-IB Example:

"RST"

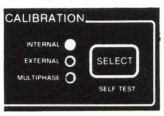
CALIBRATION AND SELF TEST



Selecting a Calibration Mode



The SELECT key selects the phase calibration source or type. Each time the SELECT key is pressed, the calibration indicators sequence through the INTERNAL, EXTERNAL, and MULTIPHASE selections. A calibration is initiated with the MANUAL key.

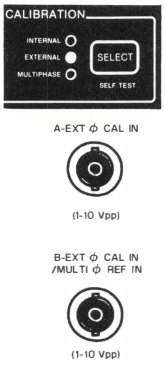


Internal Calibration

With internal calibration selected as the calibration source, the HP 3326A phase, amplitude, dc offset, and internal modulation is calibrated with internal references.

HP-IB Examples:

"CMD1"
or
"CMD INT"



External Calibration

In the 2 PHASE mode, external calibration enables the HP 3326A to sense phase at an external reference point and calibrates the channel B phase with respect to channel A phase. Phase is sensed through the rear panel A-EXT ϕ CAL IN and B-EXT ϕ CAL IN/MULTI ϕ REF IN connectors. The external calibration inputs require an input range from 3 to 10 volts peak-to-peak over the frequency range of 1 kHz to 13.1 MHz. Figure 1-27 illustrates a typical external phase calibration circuit. Amplitude, dc offset, and internal modulation are calibrated with internal references.

HP-IB Example:

"CMD2"
or
"CMD EXT"

NOTE

For maximum phase calibration accuracy, match the channel A and B external calibration cable lengths.

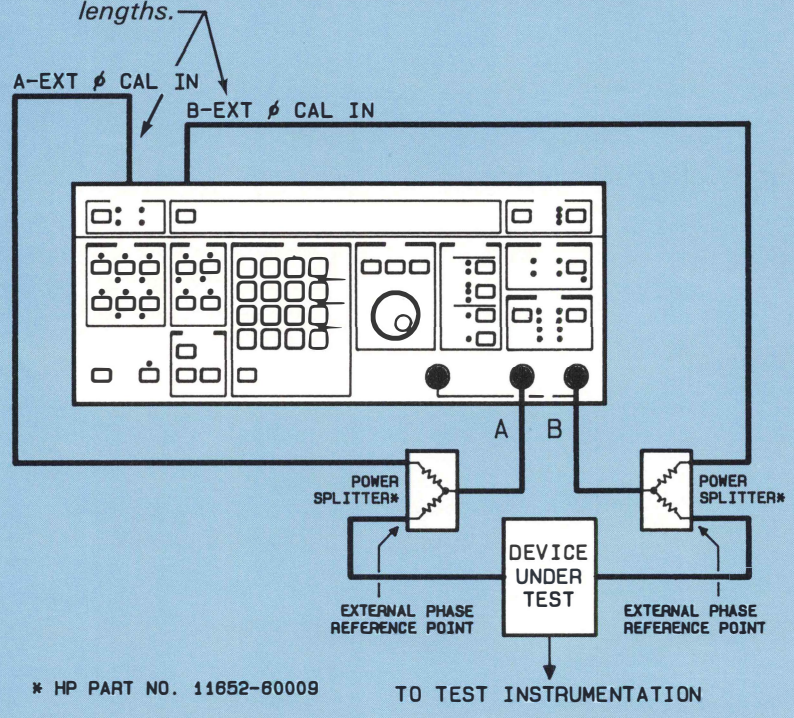
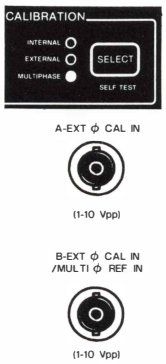


Figure 1-27. External Phase Calibration Connection Diagram



Multiphase Calibration

In the 2 PHASE mode, multiphase calibration enables the HP 3326A to maintain a calibrated phase output with respect to an external reference. The phase relationship between channel A and the external reference of the same frequency is sensed through the rear panel A-EXT ϕ CAL IN and B-EXT ϕ CAL IN/MULTI ϕ REF IN connectors. After calibrating channel A phase to the external reference, channel B phase is internally calibrated to channel A phase. The external calibration inputs require an input range from 3 to 10 volts peak-to-peak over the frequency range of 1 kHz to 13.1 MHz. Figure 1-28 illustrates a typical multiphase calibration circuit. Amplitude, dc offset, and internal modulation are calibrated with internal references.

HP-IB Example:

"CMD3"
or
"CMD MULT"

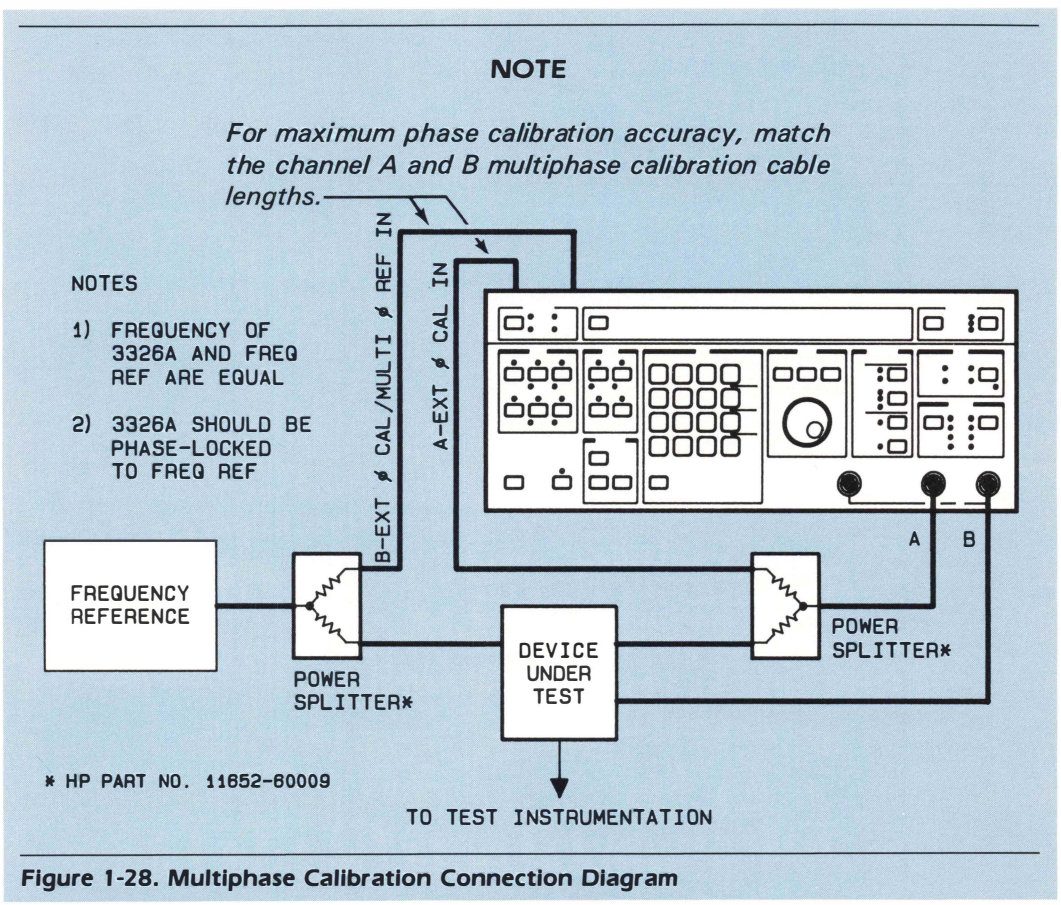


Figure 1-28. Multiphase Calibration Connection Diagram

Manual



The MANUAL key initiates a calibration each time the key is pressed. Amplitude and dc offset for the selected function, internal AM and PM (if selected), and phase (for 2 PHASE or PULSE mode) are calibrated during a manual calibration. Figure 1-29 lists other events that initiate a calibration.

HP-IB Example:

"CAL"

Automatic Calibration



An automatic calibration cycle is enabled by pressing the blue SHIFT key prior to the MANUAL key. The AUTO indicator illuminates when automatic calibration is enabled. When automatic calibration is enabled, a calibration occurs immediately after enabling automatic calibration, 5 minutes after power is applied, 15 minutes after power is applied, and at 30 minute intervals thereafter. Figure 1-29 lists the calibrations performed by the HP 3326A and the events that initiate calibration.

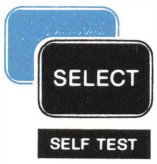
HP-IB Example:

"ACAL1"
or
"ACAL ON"

EVENT	TYPE OF CALIBRATION
Mode change	Phase calibration if changing to 2 PHASE or PULSE modes.
Function change	Phase calibration if AUTO CAL enabled.
Frequency change	PULSE mode or 2 PHASE mode phase calibration if frequency changed by more than 1 MHz since last phase calibration and AUTO CAL enabled.
Internal AM enabled	Internal AM calibration if AUTO CAL enabled.
Internal PM enabled	Internal PM calibration if AUTO CAL enabled.
HP-IB Program recall	If AUTO CAL not enabled, phase calibration if new mode is 2 PHASE or PULSE. If AUTO CAL enabled, performs manual calibration.
Manual calibration	Amplitude and dc offset for function selected, internal AM and PM (if enabled), and phase (2 PHASE or PULSE mode).
Power up and AUTO CAL	Amplitude and residual dc offset for sine, square wave, and DC functions, dc offset, phase shift of internal circuits, internal AM and PM, and phase. Phase calibration source or type is selected by CALIBRATION SELECT key.

Figure 1-29. HP 3326A Calibration

Self Test

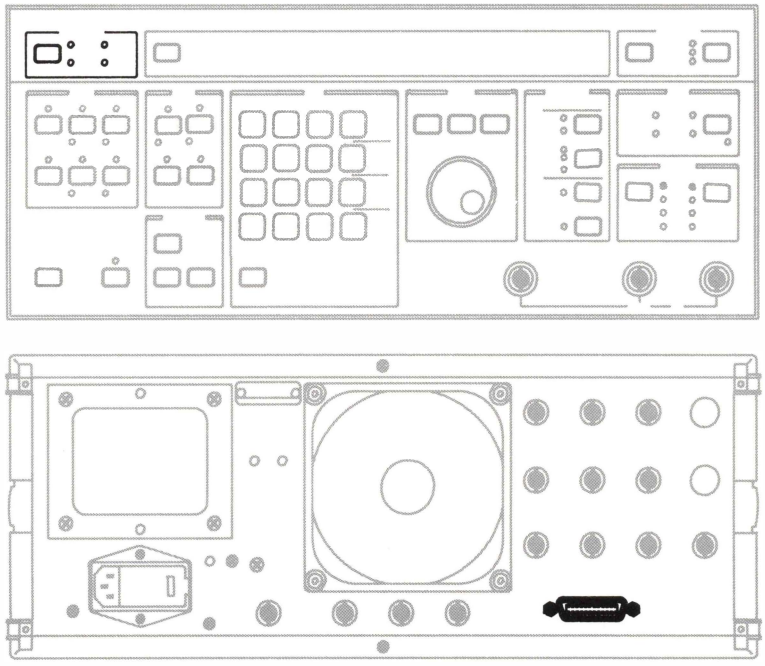


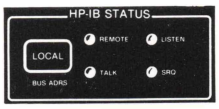
A self test is initiated by pressing the blue SHIFT key prior to the SELECT key. During a self test, all indicators and display segments briefly illuminate, and a series of internal tests is initiated. After each internal test, PASS or FAIL followed by a test number is displayed to indicate the test results. During a self test, the outputs are disabled.

HP-IB Example:

"TST"

THE HP-IB STATUS KEYS/INDICATORS/CONNECTOR





The HP-IB (Hewlett-Packard Interface Bus) Status keys and indicators are used during remote operation. An overview of the HP-IB and a description of the HP 3326A HP-IB characteristics is in Chapter II. Chapter III describes the HP 3326A commands unique to remote operation and contains a complete list of the HP-IB commands.

Local



The LOCAL key removes the HP 3326A from remote (HP-IB) operation if local lockout is not in effect and the display is not disabled. Remote operation is indicated by the illuminated REMOTE indicator.

NOTE

If "dISP OFF" (DISPlay OFF) is displayed on the HP 3326A, the display has been disabled by the DISP OFF HP-IB command. To return the HP 3326A to normal, use the DISP ON HP-IB command or apply power with the blue SHIFT key depressed (a memory clear operation).



The REMOTE indicator illuminates when the HP 3326A is operating under HP-IB control. While in remote (and local lockout is not in effect), only the LOCAL key is recognized.



The LISTEN indicator illuminates when the HP 3326A is addressed to listen over the HP-IB.



The TALK indicator illuminates when the HP 3326A is addressed to talk over the HP-IB.



The SRQ (Service ReQuest) indicator illuminates when the HP 3326A is generating an HP-IB service request.

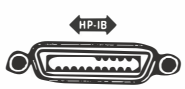
NOTE

An SRQ may be generated while the HP 3326A is in local if the status byte mask used to enable an SRQ is not reset. To extinguish the front panel SRQ indicator, set the SRQ mask to zero and perform a serial poll with a controller, or apply power with the blue SHIFT key depressed (a memory clear operation). For more information on the status byte mask, refer to "Reading and Masking the Status Byte" in chapter III.

Bus Address

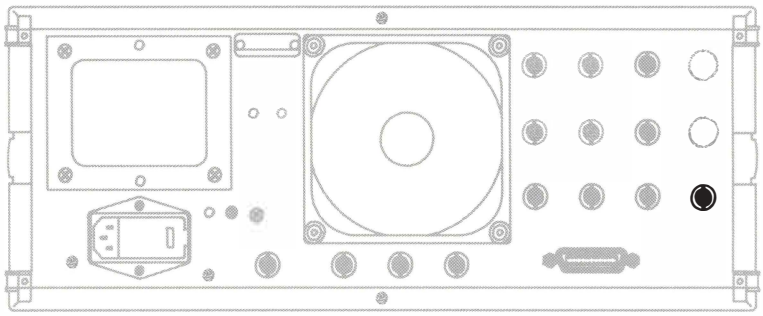


The BUS ADRS (BUS ADdReSs) key enables display or entry of the HP-IB address. The BUS ADRS key is selected by pressing the blue SHIFT key prior to the LOCAL key. After selection of the BUS ADRS key, the HP-IB address is entered with the numeric keypad. For two digit HP-IB addresses, the address is set when the second digit is entered. For single digit HP-IB addresses, the address is set when any units key is pressed. Alternately, a zero can precede the single digit to form a two digit address. The HP-IB address is an integer in the range of 0 to 30 and is retained in nonvolatile memory.



The HP 3326A is connected to other HP-IB devices through the rear panel HP-IB connector.

EXTERNAL TRIGGER



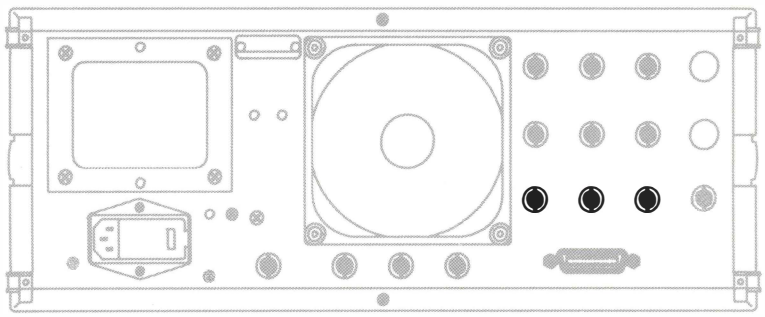
EXT TRIG IN



(TTL'L)

From the preset state, EXT TRIG IN (EXTernal TRIGger INput) is used to trigger single frequency sweeps. Triggered operation is initiated by a negative edge transition of a TTL level signal after the sweep is reset. Triggers received during a sweep reset are ignored. The shortest delay between a trigger and sweep start is when the sweep is reset prior to the trigger. The trigger functions are extended through the use of HP-IB commands described in "Triggered Sweeps" and "Modifying Parameters" in Chapter III. To inhibit inadvertently triggered sweeps, remove the trigger signal from the EXT TRIG IN connector, or disable triggered operation with the TOFF (Trigger OFF) HP-IB command.

MARKER / Z-BLANK (PEN LIFT) / X-DRIVE OUTPUTS



The MARKER OUT, Z-BLANK OUT, and X-DRIVE OUT connectors provide outputs to drive an analog plotter or oscilloscope display during sweep operation. Figure 1-30 illustrates the use of MARKER OUT to drive an oscilloscope. Figure 1-31 illustrates the oscilloscope connections used to obtain the display.

Marker Out

MARKER OUT

(TTL 'L')

The rear panel MARKER OUT connector provides a TTL level signal to indicate when the sweep frequency reaches the value entered for the marker frequency. The high to low transition in the channel B trace in Figure 1-30 illustrates the MARKER OUT level change during a sweep.

Triangle Linear Sweep

When sweeping from the start to the stop frequency, MARKER OUT drops to a low level at the selected marker frequency. When sweeping from the stop to the start frequency, MARKER OUT rises to a high level at the selected marker frequency.

Ramp Linear Sweep

When sweeping from the start to the stop frequency, MARKER OUT drops low at the selected marker frequency.

Discrete Frequency Sweep

MARKER OUT drops low at the start of each frequency element and remains low until the end of the sweep element. MARKER OUT returns to a high level briefly (10 μsecond minimum) during the transition between sweep elements.

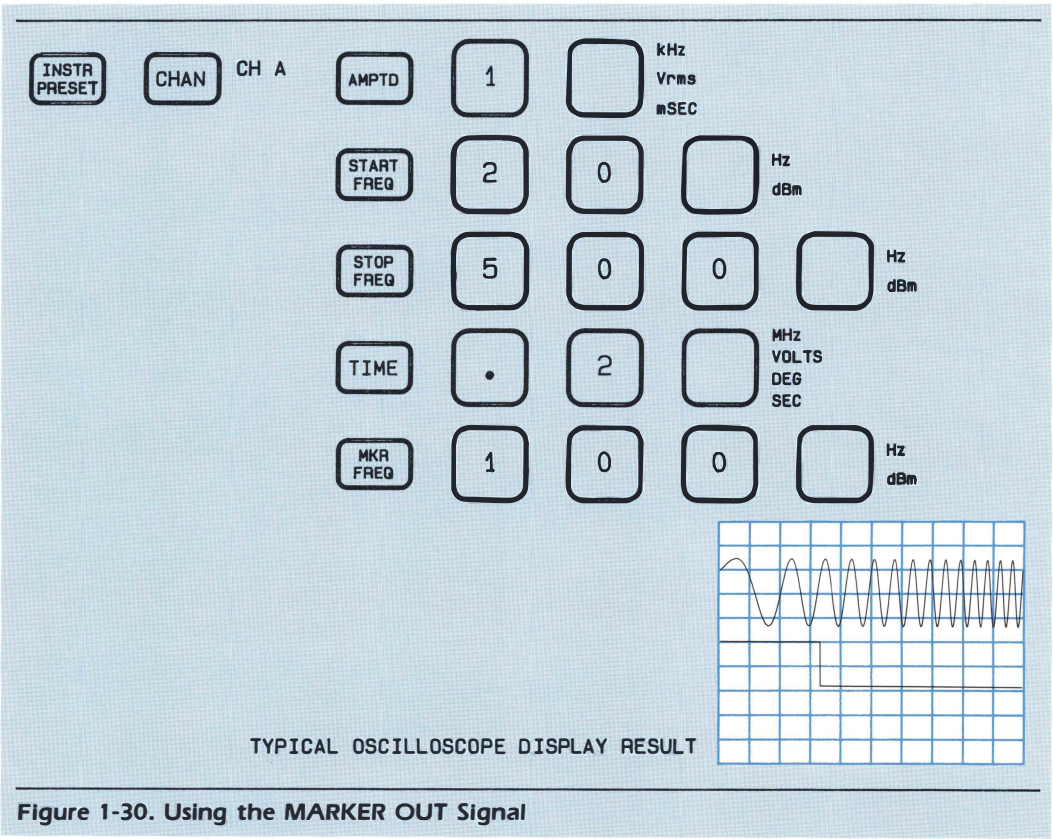


Figure 1-30. Using the MARKER OUT Signal

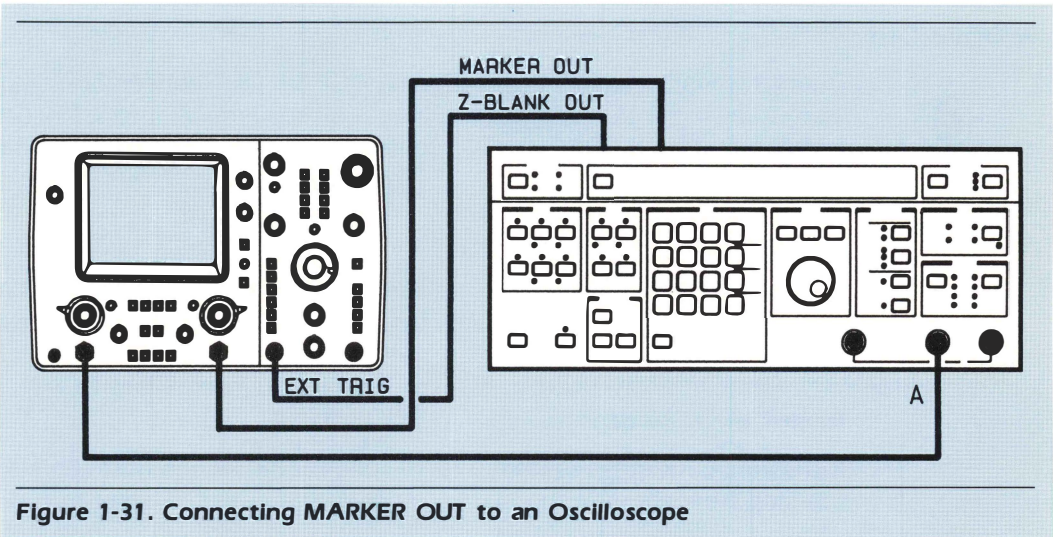


Figure 1-31. Connecting MARKER OUT to an Oscilloscope

Z-Blank Out



The Z-BLANK OUTput drops low at the start of sweep and remains low until the end of a sweep. At the end of a sweep, Z-BLANK OUT goes to a high level and remains high until another sweep segment is initiated. The Z-BLANK OUT connector is located on the rear panel and the output is TTL compatible. The Z-BLANK OUT low level is capable of sinking current from a positive voltage source through a pen-lift circuit or other device. Figure 1-32 illustrates a typical circuit for connecting Z-BLANK OUT to an oscilloscope. When used as an input, the maximum Z-BLANK OUT ratings are:

Maximum current sink: 100 mA
Allowable voltage range: 0 to +42 V dc

Ramp Linear Sweep

Z-BLANK OUT drops low at the start of sweep and remains low until the end of a sweep. At the end of a sweep, the Z-BLANK OUT goes to a high level and remains high while the frequency is reset to the start frequency.

Triangle Linear Sweep

Z-BLANK OUT drops low during the sweep from the start frequency to the stop frequency, and during the sweep from the stop frequency to the start frequency. Z-BLANK OUT is high when the HP 3326A is not sweeping.

Discrete Frequency Sweep

Z-BLANK OUT drops low at the start of a sweep sequence and remains low until the end of a sweep sequence. At the end of a sweep, Z-BLANK OUT goes to a high level and remains high until another sweep is initiated.

X-Drive Out



During sweep operation, the rear panel X-DRIVE OUT connector provides a 0 to 10 or 10 to 0 volt linear ramp proportional to the sweep time. Figure 1-30 illustrates a typical circuit that uses X-DRIVE OUT to control the horizontal deflection of the oscilloscope display.

Triangle Linear Sweep

X-DRIVE OUT increases from 0 to 10 volts for the sweep from the start frequency to the stop frequency and decreases from 10 to 0 volts for the sweep from the stop frequency to the start frequency.

Ramp Linear Sweep

X-DRIVE OUT increases from 0 to 10 volts for the sweep from the start frequency to the stop frequency. At the end of a sweep the output is reset to 0 volts.

Discrete Frequency Sweep

Normally, X-DRIVE OUT increases linearly from 0 to 10 volts during the total sweep time. If the total sweep time is between 1000 and 1024 seconds, X-DRIVE OUT increases at the lowest sweep rate with a maximum output of 10.24 volts. If the sweep time exceeds 1024 seconds, the output voltage is reduced to 0 volts and the cycle is repeated.

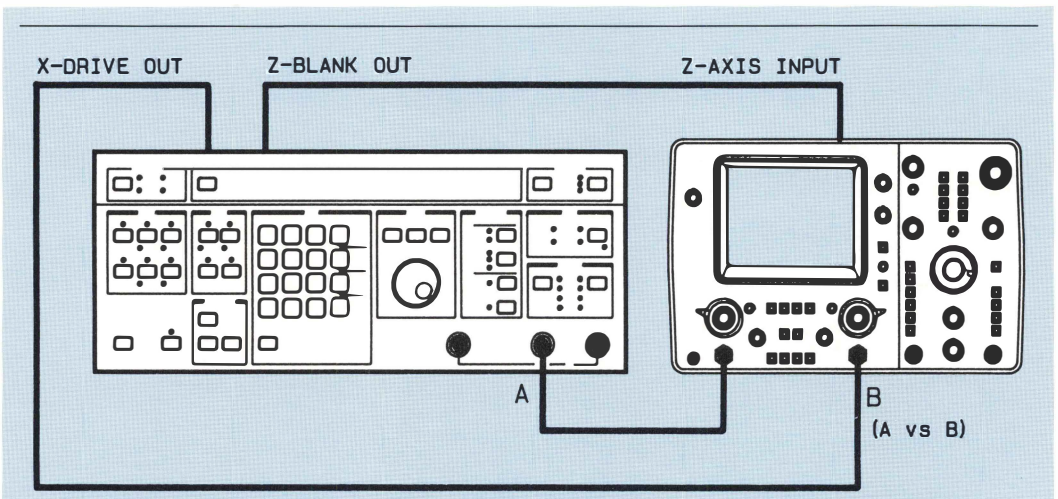
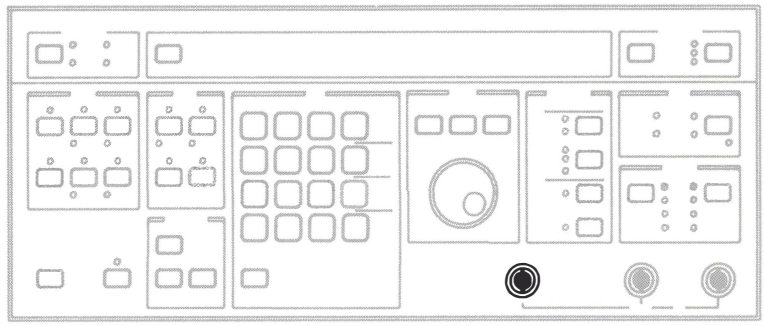


Figure 1-32. Connecting Z-BLANK OUT and X-DRIVE OUT to an Oscilloscope

SYNC A OUTPUT



SYNC A
(50 Ω)



A TTL square wave with the frequency and phase of the channel A output is available at the front panel SYNC A (SYNChronous with channel A) connector. The SYNC A transition occurs at the midpoint between peaks on the channel A signal. Figure 1-33 illustrates the oscilloscope connections used to obtain the display. Figure 1-34 illustrates the output from the SYNC A and CH A connectors. The impedance of the SYNC A output is 50 Ω. When the SYNC A output is terminated in 50 Ω, the output levels are:

Low level ≤ +0.2 V
High level ≥ +1.2 V

NOTE

If the SYNC A output is connected to a high impedance load, the voltage levels will be approximately twice the values listed. Improper termination of a 50 Ω system may cause ringing at the positive and negative transitions.

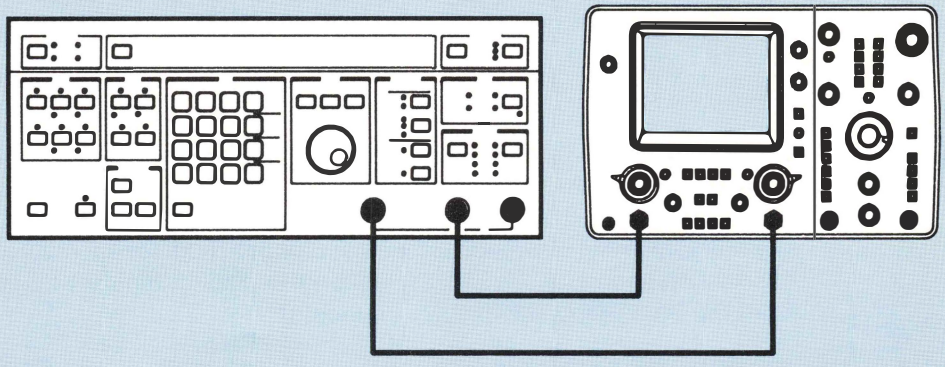


Figure 1-33. CH A and SYNC A Output Connection

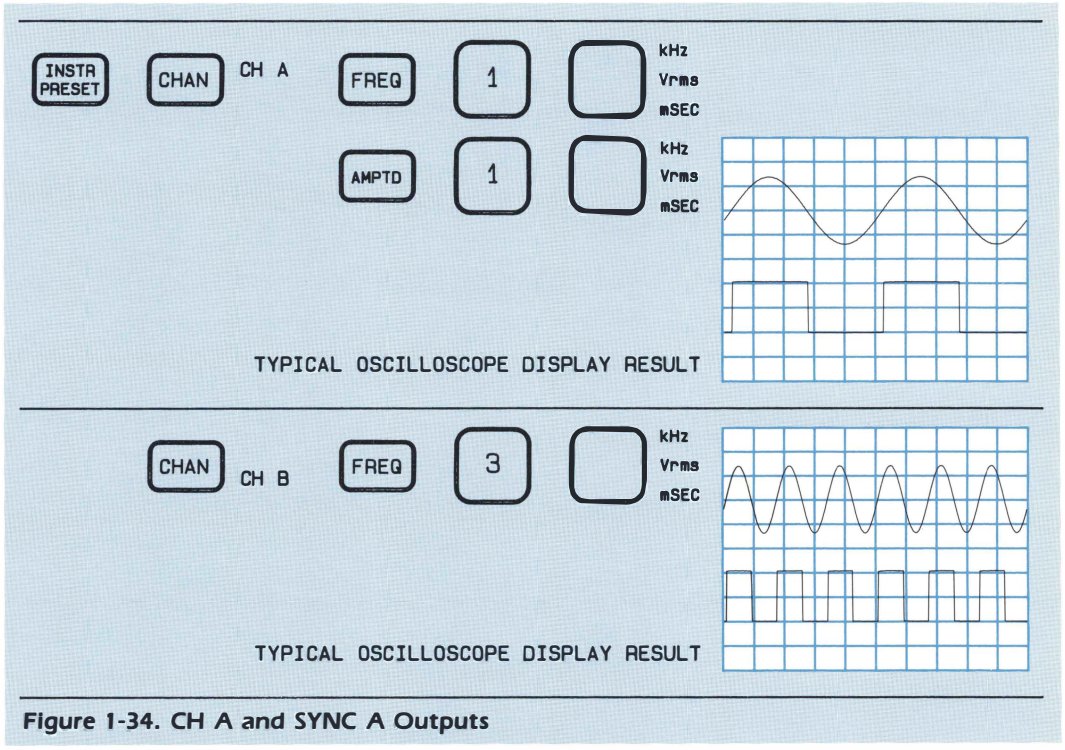
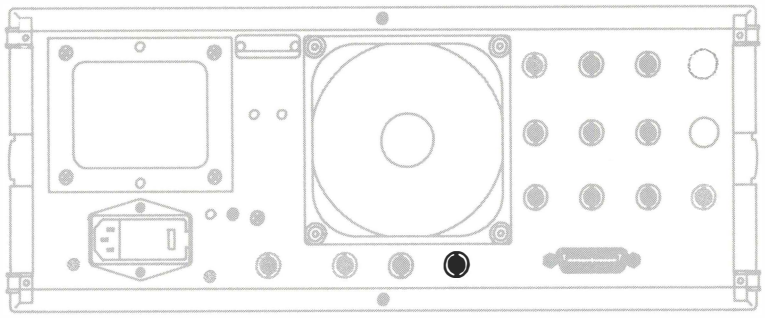
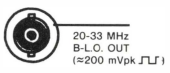


Figure 1-34. CH A and SYNC A Outputs

20-33 MHz L.O. OUTPUT (EXTENDED FREQUENCY)





The rear panel 20-33 MHz B-L.O. OUT connector supplies a signal offset by 20 MHz from the channel B output. The output is ac coupled with a level greater than 100 mV peak-to-peak into 50 ohms. The output frequency is controlled through a channel B FREQ key entry, channel B sweep, or channel B phase modulation. Figure 1-35 illustrates the oscilloscope connections used to obtain the display. Figure 1-36 illustrates the output from the 20-33 MHz B-L.O. OUT connector.

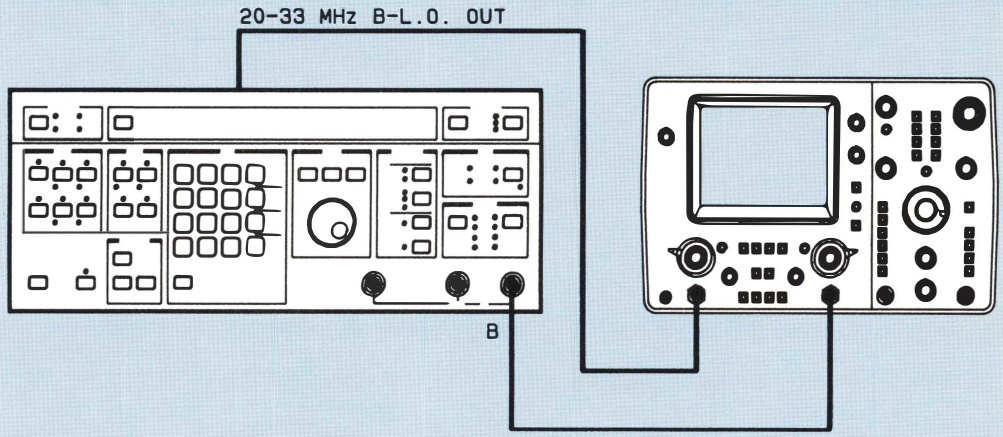
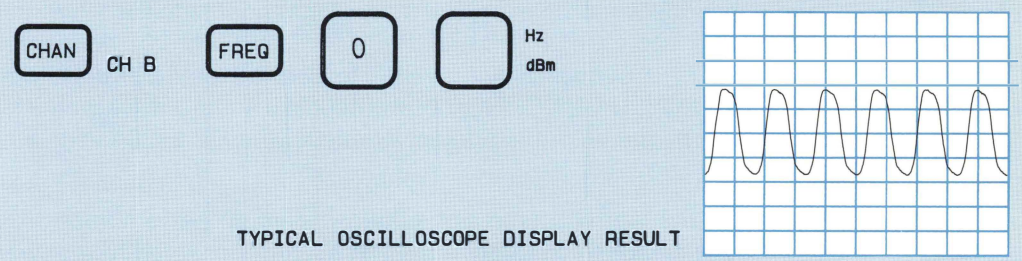


Figure 1-35. B-L.O. Output Connection



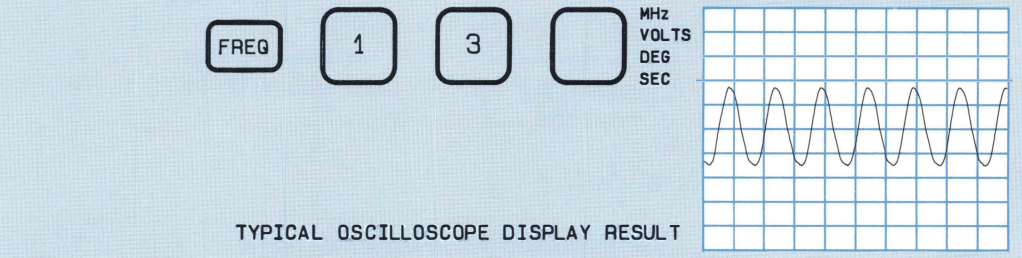
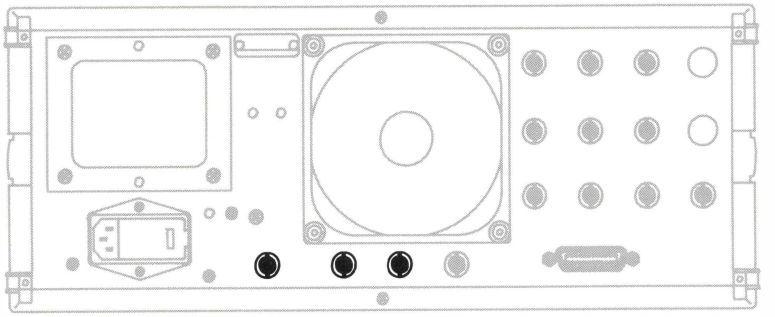


Figure 1-36. B-L.O. Output

EXTERNAL REFERENCE OR OVEN STABILIZED FREQUENCY OPTION



10 MHz Oven Output (High Stability Frequency Reference - Option 001)



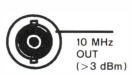
The 10 MHz OVEN OUT OPTION 001 connector is available if the high stability frequency reference (Option 001) is installed. Option 001 is a 10 MHz temperature (oven) stabilized crystal oscillator. The crystal oscillator connects to the HP 3326A frequency circuits by connecting the 10 MHz OVEN OUT OPTION 001 connector to the 1, 2, 5, 10 MHz REF IN connector with a BNC to BNC adapter (HP part number 1250-1499). The 10 MHz OVEN OUT OPTION 001 output is a square wave with a level greater than 3 dBm (50 Ω). The output is present whenever the HP 3326A is connected to a power source.

To reduce the warmup time and obtain maximum performance from an HP 3326A equipped with Option 001, leave the HP 3326A connected to a power source. Power is supplied to Option 001 whenever the HP 3326A is connected to a power source. An HP 3326A with Option 001 requires 15 minutes of operation to meet frequency specifications if power is disconnected for less than 24 hours. If power is disconnected for more than 24 hours, the HP 3326A may require up to 72 hours of operation to meet frequency specifications.

External Frequency Reference



The HP 3326A is phase-locked to external frequency references through the 1, 2, 5, 10 MHz REF IN connector. Phase-locking to an external frequency reference transfers the external reference's frequency accuracy and aging rate to the HP 3326A. The level of the frequency reference must be from 0 dBm to +20 dBm (50 Ω). The frequency must be 10 MHz (±10 ppm) or a subharmonic down to 1 MHz (e.g. 1, 2, 5, or 10 MHz). The front panel EXT REF indicator illuminates when the HP 3326A is phased-locked to an external frequency reference. The message "Error 180 XREF" (eXternal REFerence) is displayed if a signal is present and the HP 3326A is not phase-locked. The 10 MHZ OVEN OUT OPTION 001 output is connected to this connector if the high stability frequency reference (Option 001) is installed.



The 10MHz OUT connector supplies a 10 MHz square wave derived from the frequency reference of the HP 3326A. The square wave has a level greater than 3 dBm (50 Ω). This output can be used to phase-lock an analyzer or other instrumentation to the frequency reference of the HP 3326A.

CHAPTER 2
HP-IB OPERATION

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CHAPTER 2

HP-IB OPERATION

This section contains an overview of the Hewlett-Packard Interface Bus (HP-IB) and the relationship of the HP 3326A to the HP-IB. The HP-IB is a bus structure that links the HP 3326A to desktop computers, minicomputers, and other HP-IB controlled instruments to form automated measurement systems. The HP-IB is Hewlett-Packard's implementation of the IEEE Standard 488-1978 and ANSI Standard MC 1.1. The HP-IB commands specifically intended for the HP 3326A HP-IB operation are listed and described in Chapter III.

DESCRIPTION OF THE HP-IB

All of the active HP-IB interface circuits are contained within the various HP-IB controlled devices. The interconnecting cable is entirely passive and its role is limited to connecting the devices in parallel so that data can be transferred from one device to another.

Every participating device must be able to perform at least one of the following roles: talker, listener, or controller. A talker transmits data to other devices called listeners. Most devices can be both a talker and listener, but not at the same time. A controller manages the operation of the bus system by designating which device is to talk and which devices are to listen at any given time. The HP 3326A can be either a talker or a listener, but does not have talk only or listen only capabilities.

The full flexibility and power of the HP-IB is realized when a controller is added to the system. An HP-IB controller participates in the measurement by being programmed to automate, monitor, and coordinate instrument operation as well as process the measurement results. Figure 2-1 summarizes the capabilities of the HP-IB.

Number of Interconnected Devices
Up to 15 devices maximum may be on one contiguous bus.

Interconnection Path/Maximum Cable Length
Star or linear bus network. Total transmission path length = 2 meters times number of devices, or 20 meters, whichever is less, with a maximum of 3 meters separating any two devices.

Message Transfer
Byte-serial, 8 bit-parallel asynchronous data transfer using a 3 wire handshake.

Data Rate
One megabyte per second (maximum) over limited distances, actual data rate depends upon the capability of the slowest device involved in the transmission.

Address Capability
Primary addresses: 31 talk, 31 listen; secondary (2-byte) addresses, 961 talk, 961 listen. 1 Talker and 14 listeners, maximum at one time. The HP 3326A has only primary address capability. Figure 2-4 lists the talk and listen HP-IB addresses.

Multiple Controller Capability
In systems with more than one controller, only one controller can be active at a time. The active controller can pass control to another controller, but only the system controller can assume unconditional control. Only one system controller is allowed.

Interface Circuits
Driver and receiver circuits are TTL compatible.

Figure 2-1. HP-IB Specification Summary

HP 3326A HP-IB CAPABILITY

The HP 3326A interfaces to the HP-IB as defined by IEEE Standard 488-1978. The interface functional subset which the HP 3326A implements is specified in Figure 2-2.

Code	Function
SH1	Complete source handshake capability
AH1	Complete acceptor handshake capability
T6	Basic talker; serial poll; unaddressed to talk if addressed to listen; no talk only
L4	Basic listener; unaddressed to listen if addressed to talk; no listen only
SR1	Complete service request capability
RL1	Complete remote/local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT1	Device trigger capability
C0	No controller capability
E1	Driver electronics - open collector

Figure 2-2. HP 3326A HP-IB Capability

HP-IB INTERFACE MANAGEMENT LINES

Five lines in the HP-IB manage the orderly flow of information across the HP-IB. Figure 2-3 describes the lines used in managing the HP-IB.

LINE NAME	MNEMONIC	DESCRIPTION
Attention	**ATN**	Causes all devices to interpret data on the bus as a controller command and activate their acceptor handshake function (command mode) or data between addressed devices (data mode).
Interface Clear	**IFC**	Initializes the HP-IB system to an idle state (no activity on the bus).
Service Request	**SRQ**	Alerts controller to a need for communication.
Remote Enable	**REN**	Enables devices to respond to remote control when addressed to listen.
End or Identify	**EOI**	Indicates last data byte of a multibyte sequence; also used with ATN to parallel poll devices for their status bit.

Figure 2-3. HP-IB Interface Management Lines

TALK/LISTEN ADDRESSES

Each HP-IB device has at least one talk, and one listen address (unless the device is totally transparent, or a talk only or listen only device). Device addresses are used by the active controller in the COMMAND MODE (ATN true) to specify the talker (via a talk address) and the listener (via listen addresses). There may be only one talker addressed by the controller to talk at any time.

The address of a device is usually preset at the factory and is resettable during system configuration. In the binary representation of the address, the device address is the decimal equivalent of the five least significant bits of the address. (On HP-IB devices with selector switches, these are the five address switches.) The address can be from 0 to 30 inclusive. The sixth and seventh bits determine if the address is a talk or listen address respectively. High level HP-IB controllers typically configure these two bits automatically. Figure 2-4 lists the HP-IB addresses if a controller requires the talk and listen addresses.

DEVICE ADDRESS	BINARY ADDRESS	ADDRESS CHARACTERS		
		TALK	LISTEN	
0	0000 0000	@	SPACE	
1	0000 0001	A	!	
2	0000 0010	B	''	
3	0000 0011	C	#	
4	0000 0100	D	$	
5	0000 0101	E	%	
6	0000 0110	F	&	
7	0000 0111	G	'	
8	0000 1000	H	(	
9	0000 1001	I	)	
10	0000 1010	J	*	
11	0000 1011	K	+	
12	0000 1100	L	,	
13	0000 1101	M	–	
14	0000 1110	N	.	
15	0000 1111	O	/	
16	0001 0000	P	0	
17	0001 0001	Q	1	
18	0001 0010	R	2	(HP 3326A factory selected address)
19	0001 0011	S	3	
20	0001 0100	T	4	
21	0001 0101	U	5	(typically the controller)
22	0001 0110	V	6	
23	0001 0111	W	7	
24	0001 1000	X	8	
25	0001 1001	Y	9	
26	0001 1010	Z	:	
27	0001 1011	[	;	
28	0001 1100	/	<	
29	0001 1101	]	=	
30	0001 1110	^	>	

Figure 2-4. HP-IB Addresses

The talk and listen addresses fall within the printable ASCII character set. When a device receives one of these characters while ATN is true, it becomes addressed. The ASCII character "?" (ASCII 31) unaddresses all devices while ATN is true. The device address (set from the HP 3326A front panel) is used by HP-IB controllers most of which automatically send the talk and listen address characters.

VIEWING THE HP 3326A HP-IB ADDRESS

The HP-IB address of the HP 3326A is stored in a nonvolatile memory (there are no address switches). The HP 3326A address appears in the display when the BUS ADDRESS key in the HP-IB STATUS block is pressed. The BUS ADDRESS key is selected by pressing the blue SHIFT key followed by the LOCAL key. The HP 3326A address is removed from the display by pressing another key that requires the display.

CHANGING THE HP 3326A HP-IB ADDRESS

Every device on the HP-IB must have a unique address. The HP 3326A address can be set at any address between 0 and 30, inclusive and is stored in internal nonvolatile memory. When selecting an address, remember that the controller also has an address (usually 21). To change the HP-IB address:

- Press the blue SHIFT key followed by the LOCAL key in the HP-IB STATUS block to display the HP-IB address.
- Enter the address with the numeric keypad. For two digit HP-IB addresses, the address is set when the second digit is entered. For a single digit HP-IB address, the address is set when any units key is pressed. Alternately, a zero can precede the single digit to form a two digit address.

NOTE

The HP-IB address is reset to 18 after a memory clear operation.

- The message "Error 20 RNGE" is displayed if the HP-IB address exceeds 30.

BUS MESSAGES

The HP-IB interface system operates in either of two modes: command mode (ATN bus management line true) or data mode (ATN bus management line false). If an HP controller is used, the bus management lines are configured automatically and all necessary command strings are issued.

In the command mode, devices on the HP-IB can be addressed or unaddressed as listeners or talkers. Bus commands are also issued in the command mode. These commands may instruct the HP-IB interface to control the instrument (like CLEAR or TRIGGER) but are more often used for bus management (REMOTE, LOCAL, POLLs, SERV-

ICE REQUEST, ABORT interface activity, or PASS CONTROL). Bus commands are issued through one of the bus management lines or through the eight bit data bus. Figure 2-5 lists the commands used in the command mode.

In the data mode, data or instructions are transferred between instruments on the HP-IB. Instructions transferred to the instrument are called device dependent commands. All the commands specifically for the HP 3326A fall into this category. The HP 3326A device dependent commands configure the HP 3326A, initiate measurements, initiate data transfers, or define error reporting conditions. These device dependent commands are meaningless for other instruments. The HP 3326A device dependent commands are listed in Chapter III.

ABORT

The abort command (interface clear - IFC true) halts all HP-IB activity. The system controller assumes unconditional control of the bus. The HP 3326A responds by becoming unaddressed.

CLEAR

The clear command causes all devices addressed to listen to reconfigure to a predefined device dependent condition. The HP 3326A responds to the clear command (both the device clear - DCL and selective device clear - SDC) by clearing the interface command buffer of any pending commands, and clearing the status byte register, the SRQ register, and error register. The HP 3326A ends the clear cycle by setting the ready bit (bit 4) in the HP 3326A status byte.

CLEAR LOCKOUT/SET LOCAL

The clear lockout/set local command removes all devices from the local lockout mode and returns the HP 3326A to local (front panel) control. Because the REN bus management line is set false, the HP-IB is in the local mode.

LOCAL

The local command clears the remote command from the listening device and returns the listening device to local (front panel) control. If local lockout is not in effect, the HP 3326A responds by returning to front panel control. The REMOTE indicator on the front panel extinguishes if the HP 3326A is in REMOTE prior to the LOCAL command.

LOCAL LOCKOUT

The local lockout command disables the LOCAL front panel key to avoid operator interference. The HP 3326A front panel is locked out.

PARALLEL POLL

The parallel poll command is a controller operation used to obtain information from the devices under its control. The HP 3326A does not respond.

PASS CONTROL

The pass control command shifts system control from one controller to another. The HP 3326A does not respond.

Figure 2-5. HP-IB Control Commands

REMOTE

The remote command directs an instrument to take instructions from the HP-IB. To implement the remote command, the controller must set the REN bus management line true. When the HP 3326A accepts the remote command, the REMOTE front panel indicator illuminates and the front panel is disabled except for the LOCAL key. If local lockout message is issued, the mode cannot be changed from remote to local via the front panel.

SERIAL POLL

The serial poll command requests that the HP 3326A send its status byte. Encoded in the HP 3326A status word are eight bits indicating the states of several operating parameters (refer to "The Status Byte").

SERVICE REQUEST

The SRQ (service request) bus management line is used by a device to indicate the need for attention from the controller. When the HP 3326A issues an SRQ it also sets bit six of the status byte (see the Status Byte) and illuminates the front panel SRQ indicator. The SRQ is cleared by executing a serial poll of the HP 3326A.

NOTE

An SRQ may be generated while the HP 3326A is in local if the status byte mask used to enable an SRQ is not reset. To extinguish the front panel SRQ indicator, set the SRQ mask to zero and perform a serial poll with a controller, or apply power with the shift key depressed (a memory clear operation). A memory clear replaces the contents of nonvolatile memory with preset state setup data. For more information on the status byte mask, refer to "Masking the Status Byte."

TRIGGER

The group execute trigger (GET) or selective device trigger (SDT) command causes all addressed instruments with HP-IB trigger capability to execute a predefined function simultaneously. The HP 3326A responds to the HP-IB trigger as it would to an external trigger.

Figure 2-5. HP-IB Control Commands (Cont.)

SERVICE REQUEST

One of the five bus management lines connected to every device on the bus is the SRQ line. The SRQ line is used by a device to indicate the need for attention from the controller. When the HP 3326A requires service, it sets bit six of the status byte, illuminates the front panel SRQ indicator, and generates the SRQ. Bit six, the require service bit, is sometimes referred to as the status bit in connection with a poll. Any bit in the status byte may initiate an SRQ. The status byte may be masked to select which bits cause the HP 3326A to set the SRQ line.

When a controller senses an SRQ, it can poll each device to fine the device requiring service. The HP 3326A responds to a serial poll by returning its status byte.

THE STATUS BYTE

The status byte is an eight bit word transmitted by the HP 3326A in response to a serial poll. The state of each bit indicates the status of an internal HP 3326A function. Figure 2-6 describes the HP 3326A status byte bit positions, and the events and conditions that set and reset each bit. Any status bit becomes enabled (set) when the condition it represents changes from false to true. An enabled bit sets bit 6, and generates an SRQ if the Boolean AND of the status byte and the status byte mask is not equal to zero.

Status Byte Bit Numbers: B7 B6 B5 B4 B3 B2 B1 B0

BIT NUMBER	DECIMAL VALUE	DESCRIPTION
B7	128	**POWER RESTORED.** Set when power is restored to the HP 3326A after power is interrupted. Reset when the HP 3326A is preset or receives a device clear, selected device clear, or RST command.
B6	64	**REQUIRE SERVICE.** Set when the HP 3326A requires service (sent an SRQ). Cleared when the condition causing the SRQ is removed, or when the HP 3326A is preset or receives a device clear, selected device clear, or RST command.
B5	32	**ERROR.** Set when either a program or hardware error condition exists for the HP 3326A. Reset when the HP 3326A is preset, or receives a device clear command, selected device clear command, RST command, or when the error register is read with the IERR or ERR? HP-IB command.
B4	16	**READY.** Set when the HP 3326A has executed the last HP-IB command and is ready for the next command. Reset when the HP 3326A receives a device dependent command, device clear command, selected device clear command, or trigger.
B3	8	**HARDWARE ERROR.** Set when the HP 3326A detects an internal failure. Reset when the HP 3326A is preset, or receives a device clear command, selected device clear command, RST command, or when the error register is read with the IERR or ERR? HP-IB command.
B2	4	**SWEEP START/IN PROGRESS.** Set when the HP 3326A starts a sweep. Reset when the sweep is stopped (either by reaching the stop frequency or aborted by a front panel or HP-IB command). It is also reset when the HP 3326A is preset or receives a device clear command, selected device clear command, or RST command.
B1	2	**SWEEP STOPPED.** Set when the HP 3326A ends a sweep normally. Reset when the HP 3326A is preset or receives a device clear command, selected device clear command, or RST command.
B0	1	**PROGRAM ERROR.** Set when the HP 3326A receives an invalid HP-IB command (e.g. command syntax or incompatible command for mode selected). Reset with an INSTR PRESET, device clear command, selected device clear command, RST command, or when the error register is read with the IERR or ERR? HP-IB command.

Figure 2-6. HP 3326A Status Byte

MASKING THE STATUS BYTE

The HP 3326A MASK command specifies which bits in the status byte will be enabled to generate an SRQ. The MASK command has the syntax of "MASKnPC" where n is an integer number corresponding to the enabled bits in the status byte, and PC is the suffix used to end the command. The integer number is determined by summing the decimal values of the enabled bits in the status byte. Figure 2-6 describes the HP 3326A status byte and lists the decimal value of each bit position. The require service bit (bit 6) cannot be disabled.

CHAPTER 3
HP 3326A HP-IB COMMANDS

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CHAPTER 3

HP 3326A HP-IB COMMANDS

The commands for operating the HP 3326A remotely through the HP-IB are listed in this chapter. A complete HP 3326A HP-IB command summary is located at the end of this chapter. HP-IB commands corresponding to front panel keys are described in Chapter 1, Operator's Introduction. Commands used exclusively for HP-IB operation are described in this chapter. For an introduction to programming with the HP 3326A HP-IB commands, refer to the HP 3326A Introductory Operating Guide.

REMOTE FRONT PANEL OPERATION

Many of the HP-IB functions are the remote equivalent of manually pressing a front panel key and are executed in similar sequences. The major differences are for the front panel keys accessed by pressing the blue SHIFT key. These keys have their own HP-IB commands.

The HP-IB REMOTE status light, located in the HP-IB STATUS block on the left side of the front panel, indicates whether the instrument is currently operating under local (front panel control) or remote control. Remote operation is accomplished only via commands transmitted through the HP-IB.

NOTE

The REMOTE indicator on the HP 3326A can be used for a quick operational check of the HP-IB. Refer to the Controller Operating Manual for a description of the HP-IB REMOTE message. When this message is sent to the HP 3326A, the REMOTE indicator should illuminate. If this does not occur, check the cabling, the HP 3326A address, and the syntax of the controller statement.

When the HP 3326A is in local, the operation is determined solely by front panel key operation. Programming the HP 3326A to remote does not alter the current operating state. The commands sent over the HP-IB change the state of the HP 3326A. Returning to local, either by pressing the LOCAL key (if local lockout is not in effect), or by an HP-IB command, causes the HP 3326A to return to front panel control without changing the operating state.

COMMAND SYNTAX

The HP 3326A Mnemonic Summary, HP-IB Only Mnemonic Summary, and Alphabetic HP 3326A Mnemonic Summary at the end of this chapter list the HP 3326A HP-IB commands. The HP 3326A Mnemonic Summary segments the HP-IB commands into groups related to the front panel key operations. The HP-IB Only Mnemonic Summary lists the HP-IB only commands in groups of related operations. The Alphabetic HP 3326A Mnemonic Summary contains a complete alphabetic list of HP-IB commands. For an

HP-IB command requiring a range value or a suffix, the applicable range limit and suffix are also listed. The following conventions apply to the HP 3326A HP-IB commands:

- The HP 3326A accepts data in seven bit ASCII code and ignores the eighth (parity) bit.
- All characters other than A through Z, a through z, 0 through 9, plus (+), minus (−), period (.), question mark (?), and pound sign (#) are treated as command separators. Command separators may not be embedded in an HP-IB command mnemonic.
- Two successive HP 3326A HP-IB commands must be separated by a command separator, or the last character of the first command may be sent with EOI.
- Range values may be in integer, real, or exponential form. For positive values, only the first eleven digits of the mantissa are used. For negative values, only the first ten digits of the mantissa are used. Leading zeros before the decimal point are ignored.
- An HP-IB mnemonic must precede any setup data or suffix.
- After information is requested from the HP 3326A, the HP 3326A responds with the information when it is addressed to talk.

The HP 3326A uses the following forms for HP-IB commands:

COMMAND FORM	***EXAMPLE***	***EXAMPLE DESCRIPTION***
Mnemonic EOS	"CHA"	Channel A
Mnemonic Suffix EOS	"FCNA SIN"	Sine function for channel A
Mnemonic Data EOS	"HVA 0"	High voltage off
Mnemonic Range data Suffix EOS	"AM 1 VO"	Amplitude of 1 Vrms
Mnemonic ? EOS	"FR?"	Interrogate frequency

where:

— mnemonic is the HP-IB mnemonic
— EOS indicates the end of string marker (a command separator, typically the carriage return and line feed supplied by the controller)

— suffix is an alphabetic code for units, function, or mode

— data is a numeric code for a function or mode

— range data is the value for an entry parameter

— ? is used to interrogate the HP 3326A.

A program string for the HP 3326A may contain multiple HP-IB commands such as "CHA FCNA SIN HVA0 AM1VO FR?" For a program string, a command separator (in this example, a space) is required between HP-IB commands.

BUS MODES

The HP 3326A accepts data and commands from the HP-IB in either of two modes: bus mode 1 or bus mode 2. Bus mode 1 is the default operating mode for the HP 3326A. Bus mode 2 should be used if speed of communications is a critical factor in the HP-IB system.

BUSM1

In BUSM1 (BUS Mode 1), the default operating mode, the HP 3326A processes one character (byte) at a time. That is, the controller must wait for the HP 3326A to finish processing a previously accepted character before the HP 3326A will accept an additional character in the command.

NOTE

In bus mode 1, the HP 3326A buffers up to three characters. If a measurement sequence is started immediately after issuing a command to the HP 3326A, the HP 3326A may not have finished processing the last command. To check if the HP 3326A command processing is complete, monitor the ready bit in the status byte with a serial poll, or mask the status byte ready bit and monitor the SRQ line. An alternate approach to check the status of command processing is to issue the command WAIT. The HP 3326A does not finish the handshake on the command WAIT until the last character is accepted. This insures that the previous command has been processed.

BUSM2

When BUSM2 (BUS Mode 2) is in effect, the HP 3326A buffers up to 100 characters of HP-IB data. While the buffered characters are being processed, the controller can communicate with other devices on the bus. If the buffer becomes full, the HP 3326A does not complete the HP-IB handshake (i.e. delays the controller) and will not accept additional characters until all the buffered characters are processed. To check if the HP 3326A command processing is complete, monitor the ready bit in the status byte with a serial poll, or mask the status byte ready bit and monitor the SRQ line.

VIEWING THE HP 3326A HP-IB ADDRESS

The HP-IB address of the HP 3326A is stored in nonvolatile memory (there are no address switches). The HP 3326A address appears in the display when the BUS ADDRESS key in the HP-IB STATUS block is pressed. The BUS ADDRESS key is selected by pressing the blue SHIFT key followed by the LOCAL key. The HP 3326A address is removed from the display by pressing another key that requires the display.

CHANGING THE HP 3326A HP-IB ADDRESS

The HP 3326A address can be set at any address between 0 and 30, inclusive. The HP-IB address of the HP 3326A is set to 18 at the factory and stored in nonvolatile memory. When selecting an address, remember that the controller also has an address (usually 21).

To change the HP-IB address:

- Press the blue SHIFT key followed by the LOCAL key in the HP-IB STATUS block to display the HP-IB address.
- Enter the address with the numeric keypad. For two digit HP-IB addresses, the address is set when the second digit is entered. For single digit HP-IB addresses, the address is set when any units key is pressed. Alternately, a zero can precede the single digit to form a two digit address.

NOTE

The HP-IB address is reset to 18 after a memory clear operation.

- The message "Error 20 RNGE" is displayed if the HP-IB address exceeds 30.

INTERROGATING THE HP 3326A FOR SETUP PARAMETERS

The value of a setup parameter is read over the HP-IB by sending the parameter HP-IB mnemonic followed by a question mark (?). The HP-IB command summary table lists the parameters that can be interrogated and the form of the response. For example, sending the mnemonic FR? sets up the HP 3326A to respond with the frequency value for the selected channel. The frequency value is transmitted when the HP 3326A is addressed to talk. Each value is returned with units.

The HP 3326A always responds with the units Hertz for frequency values, volts peak-to-peak for amplitude values, seconds for time values, volts dc for offset values, degrees for phase, and percent for duty cycle. The HP 3326A responds with either percent or degrees for modulation level. Each interrogation response ends with a carriage return (ASCII 13) and line feed (ASCII 10) character.

DISPLAYING THE HP 3326A SETUP PARAMETERS

The current value for a setup parameter is displayed on the HP 3326A front panel if the corresponding HP-IB mnemonic is sent without data and a suffix. For example, sending the mnemonic AM displays the amplitude value for the selected channel but does not change the amplitude value.

The units for the displayed value of a setup parameter change to new units if the corresponding HP-IB mnemonic and new suffix are sent without data. For example, sending the mnemonic AM DBV displays the current amplitude value in dBV for the selected channel. Sending the AM DBV command does not change the amplitude value.

NOTE

If the display is disabled with the DSP0 or DSP OFF command, the requested value is not displayed.

MODIFYING PARAMETERS

The HP 3326A modify functions are implemented over the HP-IB with the EINC (Entry INCrement), UP, and DN (DowN) HP-IB commands. The TDN (Trigger DowN) and TUP (Trigger UP) HP-IB commands enable the HP 3326A to increment or decrement the display value whenever a trigger is received. The front panel modify controls are enabled (for local operation) and disabled with the MFY (ModiFY) command.

EINC

The amount to increment or decrement the display value is set with the EINC (Entry INCrement) HP-IB command. The EINC command includes a positive range value and a suffix applicable for the value to be modified. Values entered with the EINC command apply only to the UP, DN, TUP, and TDN HP-IB commands. Only one EINC value is stored internally by the HP 3326A. An error is generated if the display is incremented or decremented and the EINC command suffix is not compatible with the units of the displayed value. An example of the EINC command is EINC10.2KHZ.

MFY0 or MFY OFF

The MFY0 (ModiFY) or MFY OFF command disables the front panel modify controls and inhibits the flashing digit on the front panel display.

MFY1 or MFY ON

The MFY1 (ModiFY) or MFY ON command enables the front panel modify controls. The HP 3326A must be put into local before the HP 3326A accepts changes through the modify controls.

TUP and TDN

The TUP (Trigger UP) and TDN (Trigger DowN) HP-IB commands enable the HP 3326A to increment or decrement the display value by the increment set with the EINC mnemonic whenever a trigger is received. The HP 3326A responds to either a trigger applied through the rear panel EXT TRIG (EXTernal TRIGger) connector, or to the HP-IB group execute trigger command. The TUP and TDN commands do not require a range value or suffix.

TOFF

The TOFF (Trigger OFF) command disables trigger operations on the HP 3326A. Trigger operations are enabled when power is applied, after an instrument preset, or with the TDN, TUP, STC, and STS HP-IB commands.

UP and DN

The UP and DN (DowN) commands increment and decrement the display value by the increment set with the EINC mnemonic. The UP and DN commands do not require a range value or suffix.

DISPLAY CONTROL

DISP0 or DISP OFF

The DISP0 (DISPlay) or DISP OFF command inhibits the HP 3326A from displaying setup values on the front panel display. While the display is disabled, dISP OFF (diSPlay OFF) appears in the display and all front panel indicators (except the HP-IB Status) are extinguished. The display is returned to normal with the DISP1 or DISP ON command.

NOTE

If the HP 3326A is returned to local with the display disabled, the HP 3326A will not respond to the front panel keys. To restore the HP 3326A to front panel operation without a controller, apply power with the shift key depressed (a memory clear operation). A memory clear replaces the contents of the nonvolatile memory with preset state setup data, and changes the HP-IB address to 18.

DISP1 or DISP ON

The DISP1 (DISPlay) or DISP ON command enables the HP 3326A to display setup values on the front panel display. The DISP1 or DISP ON command is necessary only if the HP 3326A display is disabled during HP-IB operation.

SAVING OR RESTORING AN HP 3326A SETUP

The contents of any HP 3326A memory register can be accessed over the HP-IB. The data is transferred over the HP-IB in binary form with the LRN (LeaRN) and PRG (PRoGram) mnemonics. This binary form is useful for storing HP 3326A setup data in external memory for more permanent storage. The SAV (SAVe) mnemonic stores HP 3326A setup data in internal nonvolatile memory, and the RCL (ReCaLl) mnemonic recalls HP 3326A setup data from internal nonvolatile memory.

LRN

The LRN (LeaRN) command, combined with an integer, configures the HP 3326A to transfer the setup data stored in the nonvolatile memory register over the HP-IB. The LRN command has the syntax of LRNn where n ranges from 0 to 9 and represents the nonvolatile memory register to transfer. After the HP 3326A is addressed to talk, the ASCII characters #A followed by two length bytes and 168 bytes of binary data are transmitted by the HP 3326A. The length bytes represent the most significant and least significant bytes of the number of bytes transmitted. The binary transmission is ended with the HP-IB EOI bus management line being asserted on the last byte. Note that the controller must read the data after issuing this command.

PRG

The PRG (PRoGram) command, combined with an integer ranging from 0 to 9, prefaces the 172 bytes of binary setup data to be loaded into the HP 3326A nonvolatile memory. The integer specifies the nonvolatile memory register to receive the binary setup data. The new setup is set after the last data word is received. Data loaded into the HP 3326A must be data output by the LRN command. The received HP-IB data is checked internally to insure data integrity.

RCL

The RCL (ReCaLl) command, combined with an integer, recalls a stored instrument setup from internal memory to the current HP 3326A setup. The RCL command has the syntax of RCLn where n is an integer ranging from 0 to 9 and represents the memory register of the stored the setup data.

SAV

The SAV (SAVe) command, combined with an integer, stores the current HP 3326A setup in internal memory. The SAV command has the syntax of SAVn where n is an integer ranging from 0 to 9 and represents the memory register to receive the setup data.

HP 3326A IDENTIFICATION

ID?

The ID command transmits the HP 3326A identification code (HP3326A) to the remote interface.

REV?

The REV? command transmits a pair of revision date codes (the revision and capability date) for the program stored in the HP 3326A read only memory. The date code pair is transmitted as nnnn,nnnn where nnnn represents each four digit integer. The year since 1960 is represented by the first two digits, and the week is represented by the second two digits in each number.

SER?

The SER? (SERial number) command transmits a ten character string stored in the HP 3326A read only memory. The ten character string has the form of nnnnA0000 where nnnn represents an integer corresponding to the revision date for the HP 3326A software. The year is represented by the first two digits, and the week is represented by the second two digits. The next character in the string is the ASCII character A, and the remaining characters are zeros. The actual serial number of the HP 3326A is not stored in memory.

TRIGGERED SWEEPS

The sweep functions of the HP 3326A operate under trigger control when the STC (Sweep Triggered Continuous) or STS (Sweep Triggered Single) HP-IB commands are in effect. The HP 3326A responds to either a trigger applied through the rear panel EXT TRIG (EXTernal TRIGger) connector or to the HP-IB group execute trigger command. Refer to the controller operating manual for implementation of the group execute trigger command.

STC

The STC (Sweep Triggered Continuous) command enables the HP 3326A to initiate a continuous sweep when a trigger is received. A sweep in progress is stopped after the STC command is issued. The shortest delay ($\leq$ 10 μs) between a trigger and sweep start occurs when the trigger is preceded by the SRE (Sweep REset) command.

STS

The STS (Sweep Triggered Single) command enables the HP 3326A to initiate a single sweep when a trigger is received. A sweep in progress is stopped after the STS command is issued. The shortest delay ($\leq$ 10 μs) between a trigger and sweep start occurs when a trigger is preceded by the SRE (Sweep REset) command.

TOFF

The TOFF (Trigger OFF) command disables trigger operations on the HP 3326A. Trigger operations are enabled when power is applied, after an instrument preset, or with the TDN, TUP, STC, and STS HP-IB commands.

READING AND MASKING THE STATUS BYTE

The MASK command specifies which bits in the status byte are enabled to generate an SRQ. The status byte is an eight bit word that the HP 3326A outputs when requested by a serial poll. The state of each bit indicates the status of an internal HP 3326A function. A service request is generated when the Boolean AND of the status byte and status byte mask is not equal to zero.

MASK

The MASK command has the syntax of MASKnPC where n is an integer corresponding to the enabled bits in the status byte, and PC is the suffix used to end the command. The integer is determined by summing the decimal values of the enabled bits in the status byte. Figure 3-1 describes the HP 3326A status byte and lists the decimal value of each bit position. The require service bit (bit 6) cannot be disabled and mask programming for this bit is ignored.

Status Byte Bit Numbers: B7 B6 B5 B4 B3 B2 B1 B0

BIT NUMBER	DECIMAL VALUE	DESCRIPTION
B7	128	**POWER RESTORED.** Set when power is restored to the HP 3326A after power is interrupted. Reset when the HP 3326A is preset or receives a device clear, selected device clear, or RST command.
B6	64	**REQUIRE SERVICE.** Set when the HP 3326A requires service (sent an SRQ). Cleared when the condition causing the SRQ is removed, or when the HP 3326A is preset or receives a device clear, selected device clear, or RST command.
B5	32	**ERROR.** Set when either a program or hardware error condition exists for the HP 3326A. Reset when the HP 3326A is preset, or receives a device clear command, selected device clear command, RST command, or when the error register is read with the IERR or ERR? HP-IB command.
B4	16	**READY.** Set when the HP 3326A has executed the last HP-IB command and is ready for the next command. Reset when the HP 3326A receives a device dependent command, device clear command, selected device clear command, or trigger.
B3	8	**HARDWARE ERROR.** Set when the HP 3326A detects an internal failure. Reset when the HP 3326A is preset, or receives a device clear command, selected device clear command, RST command, or when the error register is read with the IERR or ERR? HP-IB command.
B2	4	**SWEEP START/IN PROGRESS.** Set when the HP 3326A starts a sweep. Reset when the sweep is stopped (either by reaching the stop frequency or aborted by a front panel or HP-IB command). It is also reset when the HP 3326A is preset or receives a device clear command, selected device clear command, or RST command.
B1	2	**SWEEP STOPPED.** Set when the HP 3326A ends a sweep normally. Reset when the HP 3326A is preset or receives a device clear command, selected device clear command, or RST command.
B0	1	**PROGRAM ERROR.** Set when the HP 3326A receives an invalid HP-IB command (e.g. command syntax or incompatible command for mode selected). Reset with an INSTR PRESET, device clear command, selected device clear command, RST command, or when the error register is read with the IERR or ERR? HP-IB command.

Figure 3-1. HP 3326A Status Byte

Examples: To enable the error bit (bit 5 with a decimal value of 32) to generate an SRQ, send the command MASK32PC. To enable the error bit (bit 5 with a decimal value of 32) and ready bit (bit 4 with a decimal value of 16) to generate an SRQ, send the command MASK48PC where 48 is the sum of 16 plus 32.

ERROR CODES

ERR?.

The ERR? command transmits the code for the last error that occurred, resets the error register, and resets the error bits in the status byte. Bit 5 in the status byte is set when either a program error or hardware error occurs. Bit 0 is also set when a program error occurs, and bit 3 is also set when a hardware error occurs. Figure 3-2 summarizes the error codes and Appendix A provides additional detail on the error codes.

CODE	DESCRIPTION
10	HP-IB command has syntax error or contains illegal characters
11	Front panel key pressed while HP 3326A in remote
12	LOCAL key pressed while HP 3326A in local lockout
20	Value entered for selected parameter exceeds valid limits
21	In 2 TONE mode, channel B offset frequency greater than 100 kHz
23	Discrete frequency sweep element save nonsequential with existing elements, or instrument state save breaks continuity of discrete frequency elements
24	Marker frequency entered is outside sweep span
25	Frequency value greater than 1 MHz entered with high voltage option active
26	Frequency value greater than 5 kHz entered with internal PM active, or greater than 100 kHz with internal AM active
40	Value that cannot be displayed has been interrogated over the HP-IB
46	Internal modulation enabled and Channel B amplitude or offset selected as display value
47	Channel B phase selected as display value when PULSE mode enabled
50	Units conversion results in zero display value
60	Units key or suffix used improper for parameter selected
65	High voltage option enabled and dBm selected as units
70	Increment value or units incompatible with displayed value

Figure 3-2. Error Messages

80	Combined operation selected but not enabled because current amplitude value is too large, or amplitude modulation selected but not enabled because current amplitude and offset values are too large.
86	Combined operation selected but not enabled because Internal AM or PM is enabled
87	2 CHANNEL mode — synchronous PM is selected but not enabled 2 PHASE or 2 TONE mode — internal AM or PM is selected but not enabled — external PM is selected but not enabled PULSE mode — sine wave or dc only output is selected but not enabled (HP-IB) — combined operation is selected but not enabled — zero phase cannot be assigned to channel B — channel B phase offset cannot be cleared — internal AM or PM is selected but not enabled — external PM is selected but not enabled
88	Internal PM selected with channel B frequency greater than 5 kHz, or internal AM selected with channel B frequency greater than 100 kHz, or sweeping above these frequencies with AM or PM selected.
89	Combined operation selected but not enabled because AM or PM enabled
90	Frequency sweep start and stop frequencies are equal for both channels
94	Pulse duty cycle too narrow for sweep range
95	High voltage option enabled and sweep frequency is greater than 1 MHz
96	Channel B frequency exceeds 5 kHz internal PM limit or 100 kHz internal AM limit during sweep
100	Sweep rate less than 5 mHz/s or greater than 0.5 MHz/ms
110	No discrete frequency sweep elements exist for discrete frequency sweep
114	Frequency too high for duty cycle requested during discrete frequency sweep
115	High voltage option enabled and discrete frequency sweep element frequency exceeds 1 MHz
116	Channel B frequency exceeds 5 kHz internal PM limit or 100 kHz internal AM limit during discrete frequency sweep
117	Discrete frequency elements in memory incompatible with selected mode
120	Cannot clear channel A phase offset
130	High voltage option selected and not installed
136	Channel B high voltage option selected with internal modulation
138	High voltage option selected and frequency is greater than 1 MHz; or frequency sweeps above 1 MHz; or combiner enabled with frequency of either channel above 1 MHz.

Figure 3-2. Error Messages (Cont.)

140	A checksum error for recall, learn, or program operation
150	Current instrument configuration incompatible with recalled or programmed state
160	Error detected in an instrument state recalled from memory; instrument state replaced with preset state
170	Channel A output overloaded
171	Channel B output overloaded
172	SYNC A output overloaded
173	Channel A voltage controlled oscillator unlocked
174	Channel B voltage controlled oscillator unlocked
180	HP 3326A cannot lock to external reference signal that is present
190	Unsuccessful internal AM or PM calibration
191	Unsuccessful phase calibration
192	Unsuccessful amplitude calibration
193	Unsuccessful dc offset calibration
194	Unsuccessful residual dc offset calibration

Figure 3-2. Error Messages (Cont.)

HP 3325A COMPATIBILITY

For compatibility with existing programs, the HP 3326A supports many of the HP 3325A Synthesizer/Function Generator HP-IB commands. The major changes required in adapting an HP 3325A program for HP 3326A operation are adding the CHA or CHB command to specify the affected channel of the HP 3326A, and reducing frequency values greater than 13 MHz. Figure 3-3 lists the mnemonics unique to HP 3325A that are recognized by the HP 3326A. For HP 3325A compatibility, the HP 3326A also recognizes interrogations for entered values that have the letter I preceding the mnemonic.

HP 3325A COMMAND	HP 3326A COMMAND	DESCRIPTION
AC	CAL	Calibrate
AP	ZPH	Zero phase
DB	DBM	
DE	DEG	Degrees
ER	ERR	Error interrogation
FU	FCNA, B	Function (FU1 and FU2 from HP 3325A only)
HV	HVA, HVB	High voltage option
KH	KHZ	Kilohertz
MA	AEA, BEA	External AM for the selected channel
MD	BUSM	Bus mode
MH	MHZ	Megahertz
MP	AEP, BEP	External PM for the selected channel
MR	none	Millivolts rms
MV	none	Millivolts
RE	RCL	Recall
SE	SEC	Seconds
SR	SAV	Save
TE	TST	Self test
TI	STIM	Sweep time
VR	VRMS	Volts rms

Figure 3-3. HP 3325A Supported Commands

UNITS

Figure 3-4 lists the units used with the HP-IB mnemonics.

SUFFIX	DESCRIPTION
DBM	dBm: dB with respect to 1 milliwatt with 50 Ω impedance
DBV	dBV: dB with respect to 1 Volt rms
DEG	Degrees
HZ	Hertz
KHZ	Kilohertz
MHZ	Megahertz
MS	Milliseconds
PC	Percent
SEC	Seconds
VO	Volts peak-to-peak for amplitude, volts dc for dc offset.
VRMS	Volts rms for amplitude

Figure 3-4. Units Used With HP-IB Mnemonics

HP 3326A HP-IB MNEMONICS SUMMARIES

The HP 3326A mnemonic summaries list the HP 3326A HP-IB commands. Entries in the mnemonic, range, and suffix columns are listed in the order used in an HP-IB command. In each case the mnemonic is required. If either a range value or suffix is required to complete a command, it is listed following the mnemonic. Units listed in the range column are for reference. The applicable units for a mnemonic and range value appear in the suffix column.

NOTE

The listed range values are set by the preset state. These values vary as a result of the HP 3326A functions and options selected. Frequency range is changed by internal modulation, high voltage option and two-tone mode. Output amplitude range is changed with the selection of DC OFFSET, combiner, and high voltage option. DC OFFSET is changed with the selection of function, combiner, high voltage option, and amplitude.

The interrogation response column lists the form of the response after interrogating the HP 3326A. To interrogate the HP 3326A for a setup value, issue only the HP-IB mnemonic followed by a question mark (?). Sending an HP-IB mnemonic and question mark for a function that does not respond to an interrogation generates an HP-IB syntax error. The # in the interrogation response column represents a decimal digit and does not appear in the interrogation response. The HP 3326A transmits the interrogation response when it is addressed to talk.

The description column lists a short description of the HP-IB command function, the syntax of the command string, and applicable resolution for the range.

HP 3326A HP-IB MNEMONIC SUMMARY

	Front Panel Control	Mnemonic	Range	Suffix	Interrogation Response	Description Resolution Syntax
CALIBRATION BLOCK						
	AUTO	ACAL or ACAL	0-1 —	— OFF, ON	ACAL#	AutoCALibration Syntax: "ACAL0" "ACAL OFF"
	MANUAL	CAL	—	—	—	CALibrate Syntax: "CAL"

	SELECT	CMD or CMD CMD or CMD CMD or CMD	1 — 2 — 3 —	— INT — EXT — MULT	— — — 	Calibration MoDe - INTernal Syntax: "CMD1" "CMD INT" Calibration MoDe - EXTernal Syntax: "CMD1" "CMD EXT" Calibration MoDe - MULTiphase Syntax: "CMD3" "CMD MULT"
	SELF TEST	TST	—	—	##############	self TeST, each # = P or F for Pass or Fail Syntax: "TST"
ENTRY BLOCK						
	AMPTD	AM	0-10 V	VO, VRMS, DBM, DBV	AM ±#.###E±##VO	AMplitude Resolution: 1 mV p-p Syntax: "AM1.125VRMS"
	ASGN ZERO ϕ	ZPH	—	—	—	Zero PHase Syntax: "ZPH"
	CLR ϕ OFS	COF	—	—	—	Clear phase OFfset Syntax: "COF"
	DC OFFSET	OF	±5 V	VO	OF ±#.####E±##VO	OFfset Resolution: 10 mV Syntax: "OF3.02VO"
	FREQ	FR	0-13 MHz	HZ, KHZ, MHZ	FR #####.######HZ or FR ########.###HZ	FRequency Resolution: 1 μHz <100 kHz 1 mHz >= 100 kHz Syntax: "FR7.5MHZ"
	PHASE	PH	±720°	DEG	PH ±#.####E±##DEG	PHase Resolution: 0.01° Syntax: "PH180.05DEG"
	DUTY CYCLE	DUTY	1-99%	PC	DUTY#.####E±##PC	DUTY cycle Resolution: 0.01% Syntax: "DUTY25.50PC"
	% AM/ PM DEV	ML or ML	0-100% 0-360°	PC DEG	ML ±#.###E±##PC or ML ±#.###E±##DEG	Modulation Level Resolution: 0.1% 1° Syntax: "ML30.5PC"

FUNCTION BLOCK						
	CHA	FCNA or FCNA	0 —	— OFF	—	FunCtioN channel A OFF Syntax: "FCNAO" "FCNA OFF"
		FCNA or FCNA	1 —	— SIN	—	FunCtioN channel A SINe Syntax: "FCNA1" "FCNA SIN"
		FCNA or FCNA	2 —	— SQR	—	FunCtioN channel A SQuaRe Syntax: "FCNA2" "FCNA SQR"
		FCNA or FCNA	3 —	— DC	—	FunCtioN channel A DC Syntax: "FCNA3" "FCNA DC"
	CH A HV	HVA or HVA	0-1 —	— OFF, ON	—	High Voltage channel A Syntax: "HVA1" "HVA ON"
	CHB	FCNB or FCNB	0 —	— OFF	—	FunCtioN channel B OFF Syntax: "FCNBO" "FCNB OFF"
		FCNB or FCNB	1 —	— SIN	—	FunCtioN channel B SINe Syntax: "FCNB1" "FCNB SIN"
		FCNB or FCNB	2 —	— SQR	—	FunCtioN channel B SQuaRe Syntax: "FCNB2" "FCNB SQR"
		FCNB or FCNB	3 —	— DC	—	FunCtioN channel B DC Syntax: "FCNB3" "FCNB DC"
	CH B HV	HVB or HVB	0-1 —	— OFF, ON	—	High Voltage channel B Syntax: "HVB1" "HVB ON"

INSTR STATE BLOCK

INSTR PRESET	RST	—	—	—	ReSeT Syntax: "RST"
RCL DISCRETE	DRCL	00-62	—	—	Discrete ReCaLl Syntax: "DRCL02"
RECALL	RCL	0-9	—	—	ReCaLl Syntax: "RCL3"
CLR DISCRETE	CLR	—	—	—	Discrete sweep CLeaR Syntax: "DCLR"
SAVE	SAV	0-9	—	—	SAVe Syntax: "SAV3"
SAVE DISCRETE	DSAV	00-62	—	—	Discrete SAVe Syntax: "DSAV02"

MODE BLOCK

COMBINED	CMB or CMB	0-1 —	— OFF, ON	—	CoMBiner Syntax: "CMB1" "CMB ON"
MODE	MODE or MODE	1 —	— TWOC	—	MODE TWO Channel Syntax: "MODE1" "MODE TWOC"
	MODE or MODE	2 —	— TWOP	—	MODE TWO Phase Syntax: "MODE2" "MODE TWOP"
	MODE or MODE	3 —	— TWOT	—	MODE TWO Tone Syntax: "MODE3" "MODE TWOT"
	MODE or MODE	4 —	— PULS	—	MODE PULSe Syntax: "MODE4" "MODE PULS"

MODIFY BLOCK

ON/OFF	MFY or MFY	0-1 —	— OFF, ON	—	front panel ModiFY control Syntax: "MFY1" "MFY ON"

MODULATION BLOCK						
	CH A	AEA or AEA	0-1 —	— OFF, ON	—	Channel A External Amplitude modulation Syntax: "AEA1" "AEA ON"
		AEP or AEP	0-1 —	— OFF, ON	—	Channel A External Phase modulation Syntax: "AEP1" "AEP ON"
		AIA or AIA	0-1 —	— OFF, ON	—	Channel A Internal Amplitude modulation Syntax: "AIA1" "AIA ON"
		AIP or AIP	0-1 —	— OFF, ON	—	Channel A Internal Phase modulation Syntax: "AIP1" "AIP ON"
		SPE or SPE	0-1 —	— OFF, ON	—	Synchronous Phase modulation External Syntax: "SPE1" "SPE ON"
	CH B	BEA or BEA	0-1 —	— OFF, ON	—	Channel B External Amplitude modulation Syntax: "BEA1" "BEA ON"
		BEP or BEP	0-1 —	— OFF, ON	—	Channel B External Phase modulation Syntax: "BEP1" "BEP ON"
	none	NOM	—	—	—	NO Modulation Syntax: "NOM"
STATUS BLOCK						
	CHAN	CHA	—	—	—	select CHannel A Syntax: "CHA"
		CHB	—	—	—	select CHannel B Syntax: "CHB"
SWEEP BLOCK						
	CONT	SC	—	—	—	Sweep, Continuous Syntax: "SC"
	CNTR FREQ	CF	0-13 MHz	HZ, KHZ, MHZ	CF #####.######HZ or CF ########.###HZ	Center Frequency Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "CF10KHZ"

DISCRETE	SM or SM	3 —	— DSCR	—	Sweep Mode - DiSCRete Syntax: "SM3" "SM DSCR"
MKR FREQ	MF	0-13 MHz	HZ, KHZ, MHZ	MF #####.######HZ or MF ########.###HZ	Marker Frequency Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "MF8.0MHZ"
MKR-> CF	CFM	—	—	—	Center Frequency from Marker Syntax: "CFM"
RESET SWP	SRE	—	—	—	Sweep REset Syntax: "SRE"
SINGLE	SS	—	—	—	Sweep Single Syntax: "SS"
SPAN	SPAN	0-13 MHz	HZ, KHZ, MHZ	SPAN#####.######HZ or SPAN########.###HZ	sweep frequency SPAN Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "SPAN10MHZ"
START FREQ	ST	0-13 MHz	HZ, KHZ, MHZ	ST #####.######HZ or ST ########.###HZ	STart frequency Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "ST3.567891KHZ"
STOP FREQ	SP	0-13 MHz	HZ, KHZ, MHZ	SP #####.######HZ or SP ########.###HZ	StoP frequency Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "SP7.1E6HZ"
TIME	STIM	5 ms-1000 s	SEC, MS	STIM ± #.####E ± ##SEC	Sweep TIMe Resolution: 1 MS Syntax: "STIM.3MS"
TRIANGLE	SM or SM	1 —	— RAMP	—	Sweep Mode - linear RAMP Syntax: "SM1" "SM RAMP"
	SM or SM	2 —	— TRGL	—	Sweep Mode - linear TRianGLe Syntax: "SM2" "SM TRGL"

HP-IB ONLY MNEMONIC SUMMARY

BUS MODES					
	BUSM	1-2	—	—	BUS Mode Syntax: "BUSM2"
	WAIT	—	—	—	no operation Syntax: "WAIT"
DISPLAY CONTROL					
	DISP or DISP	0-1 —	— OFF, ON	—	DISPlay control Syntax: "DISP1" "DISP ON"
ERROR CODES					
	ERR?	—	—	ERR ###	ERRor code Syntax: "ERR?"
HP 3326A IDENTIFICATION					
	ID?	—	—	HP3326A	IDentification Syntax: "ID?"
	RDY?	—	—	0	ReaDY Syntax: "RDY?"
	REV?	—	—	####,####	REVision Syntax: "REV?"
	SER?	—	—	####A00000	SERial number Syntax: "SER?"
MODIFYING PARAMETERS					
	DN	—	—	—	DowN increment by EINC value Syntax: "DN"
	EINC	see description		—	Entry INCrement for UP, DN, TUP, and TDN commands Use increment resolution and suffix appropriate for entry value modified Syntax: "EINC1HZ" "EINC.1VRMS"
	UP	—	—	—	UP increment by EINC value Syntax: "UP"

READING AND MASKING THE STATUS BYTE	MASK	0-255	PC	MASK###PC	srq MASK (weighted binary sum of bit positions) Syntax: "MASK32PC"
SAVING OR RESTORING AN HP 3326A SETUP	LRN	0-9	—	—	LeaRN (read) nonvolatile memory Syntax: "LRN3"
	PRG	0-9		—	ProGram (restore) nonvolatile memory Syntax: "PRG3"
TRIGGERED OPERATION	STC	—	—	—	Sweep Triggered Continuous Syntax: "STC"
	STS	—	—	—	Sweep Triggered Single Syntax: "STS"
	TDN	—	—	—	Trigger DowN increment by EINC amount Syntax: "TDN"
	TOFF	—	—	—	Trigger OFF Syntax: "TOFF"
	TUP	—	—	—	Trigger UP increment by EINC amount Syntax: "TUP"

ALPHABETIC LISTING OF HP-IB MNEMONICS

Mnemonic	Range	Suffix	Front Panel Control	Description Resolution Syntax
ACAL	0-1 or —	— OFF, ON	AUTO	AutoCALibration Syntax: "ACAL0" "ACAL OFF"
AEA	0-1 or —	— OFF, ON	CH A	Channel A External Am Syntax: "AEA1" "AEA ON"
AEP	0-1 or —	— OFF, ON	CH A	Channel A External Pm Syntax: "AEP1" "AEP ON"
AIA	0-1 or —	— OFF, ON	CH A	Channel A Internal Am Syntax: "AIA1" "AIA ON"
AIP	0-1 or —	— OFF, ON	CH A	Channel A Internal Pm Syntax: "AIP1" "AIP ON"
AM	0-10 V	VO, VRMS, DBM, DBV	AMPTD	AMplitude Resolution: 1 mVpp Syntax: "AM1.125VO"
BEA	0-1 or —	— OFF, ON	CH B	Channel B External Am Syntax: "BEA1" "BEA ON"
BEP	0-1 or —	— OFF, ON	CH B	Channel B External Pm Syntax: "BEP1" "BEP ON"
BUSM	1-2	—	none	BUS Mode Syntax: "BUSM2"
CAL	—	—	MANUAL	CALibrate Syntax: "CAL"
CF	0-13 MHz	HZ, KHZ, MHZ	CNTR FREQ	Center Frequency Resolution: 1 μHz < 100 kHz 1 mHz >= 100 kHz Syntax: "CF10KHZ"
CFM	—	—	MKR->CF	Center Frequency from Marker Syntax: "CFM"

CHA	—	—	CHAN	select CHannel A Syntax: "CHA"
CHB	—	—	CHAN	select CHannel B Syntax: "CHB"
CMB	0-1 or —	— OFF, ON	COMBINED	CoMBiner Syntax: "CMB1" "CMB ON"
CMD	1 or —	— INT	SELECT	Calibration MoDe - INTernal Syntax: "CMD1" "CMD INT"
	2 or —	— EXT		Calibration MoDe - EXTernal Syntax: "CMD1" "CMD EXT"
	3 or —	— MULT		Calibration MoDe - MULTiphase Syntax: "CMD3" "CMD MULT"
COF	—	—	CLR ϕ OFS	Clear phase OFfset Syntax: "COF"
DBM	—	—	units	DBM
DBV	—	—	units	DBV
DC	—	—	none	suffix DC function output
DCLR	—	—	CLR DISCRETE	Discrete sweep CLeaR Syntax: "DCLR"
DEG	—	—	units	DEGrees
DN	—	—	none	DowN increment by EINC value Syntax: "DN"
DRCL	00-62	—	RCL DISCRETE	Discrete ReCaLl Syntax: "DRCL02"
DSAV	00-62	—	DISCRETE STO	Discrete SAVe Syntax: "DSAV02"
DSCR	—	—		Suffix - DiSCRete Sweep Mode
DISP	0-1 or —	— OFF, ON	none	DISPlay control Syntax: "DISP1" "DISP ON"

DUTY	1-99%	PC	DUTY CYCLE	DUTY cycle Resolution: 0.01% Syntax: "DUTY25.05PC"
EINC	see description		none	Entry INCrement for UP, DN, TUP, and TDN commands Use increment resolution and suffix appropriate for entry value modified Syntax: "EINC1HZ" "EINC.1VRMS"
ERR?	—	—	none	ERRor code Syntax: "ERR?"
EXT	—	—	none	suffix for EXTernal calibration
FCNA	0 or —	— OFF	CHA	FunCtioN channel A OFF Syntax: "FCNA0" "FCNA OFF"
	1 or —	— SIN		FunCtioN channel A SINe Syntax: "FCNA1" "FCNA SIN"
	2 or —	— SQR		FunCtioN channel A SQuaRe Syntax: "FCNA2" "FCNA SQR"
	3 or —	— DC		FunCtioN channel A DC Syntax: "FCNA3" "FCNA DC"
FCNB	0 or —	— OFF	CHB	FunCtioN channel B OFF Syntax: "FCNB0" "FCNB OFF"
	1 or —	— SIN		FunCtioN channel B SINe Syntax: "FCNB1" "FCNB SIN"
	2 or —	— SQR		FunCtioN channel B SQuaRe Syntax: "FCNB2" "FCNB SQR"
	3 or —	— DC		FunCtioN channel B DC Syntax: "FCNB3" "FCNB DC"

FR	0-13 MHz	HZ, KHZ, MHZ	FREQ	FRequency Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "FR7.500003MHZ"
HVA	0-1 or —	— OFF, ON	CH A HV	High Voltage channel A Syntax: "HVA1" "HVA ON"
HVB	0-1 or —	— OFF, ON	CH B HV	High Voltage channel B Syntax: "HVB1" "HVB ON"
HZ	—	—	units	HertZ
ID?	—	—	none	IDentification Syntax: "ID?"
INT	—	—	none	suffix for INTernal calibration
KHZ	—	—	units	KiloHertZ
LRN	0-9	—	none	LeaRN (read) nonvolatile memory Syntax: "LRN3"
MASK	0-255	PC	none	srq MASK (weighted binary sum of bit postions) Syntax: "MASK32PC"
MF	0-13MHz	HZ, KHZ, MHZ	MKR FREQ	Marker Frequency Resolution: 1 μHz <100 kHz 1 mHz > = 100 kHz Syntax: "MF8.0MHZ"
MFY	0-1 or —	— OFF, ON	ON/OFF	front panel ModiFY control Syntax: "MFY1" "MFY ON"
MHZ	—	—	units	MegaHertZ
ML	0-100% or 0-360°	PC DEG	% AM/PM DEV	Modulation Level Resolution: 0.1% 1° Syntax: "ML30PC"

MODE	1 or —	— TWOC	MODE	MODE TWO Channel Syntax: "MODE1" "MODE TWOC"
	2 or —	— TWOP		MODE TWO Phase Syntax: "MODE2" "MODE TWOP"
	3 or —	— TWOT		MODE TWO Tone Syntax: "MODE3" "MODE TWOT"
	4 or —	— PULS		MODE PULSe Syntax: "MODE4" "MODE PULS"
MS	—	—	units	MilliSeconds
MULT	—	—	none	suffix for MULTiphase calibration
NOM	—	—	none	NO Modulation Syntax: "NOM"
OF	+-5 V	VO	DC OFFSET	OFfset Resolution: 10 mV Syntax: "OF3VO"
OFF	—	—	none	suffix to disable function
ON	—	—	none	suffix to enable function
PC	—	—	units	PerCent
PH	+-720°	DEG	PHASE	PHase Resolution: 0.01° Syntax: "PH180DEG"
PRG	0-9	—	none	PRoGram (restore) nonvolatile memory Syntax: "PRG3"
PULS	—	—	none	suffix for PULSe mode
RAMP	—	—	none	suffix for RAMP sweep
RCL	0-9	—	RECALL	ReCaLl Syntax: "RCL3"
RDY?	—	—	none	ReaDY Syntax: "RDY?"
REV?	—	—	none	REVision Syntax: "REV?"

RST	—	—	INSTR PRESET	ReSeT Syntax: "RST"
SAV	0-9	—	STORE	SAVe Syntax: "SAV3"
SC	—	—	CONT	Sweep, Continuous Syntax: "SC"
SEC	—	—	units	SEConds
SER?	—	—	none	SERial number Syntax: "SER?"
SIN	—	—		suffix for SINe wave function
SM	1 or —	— RAMP	TRIANGLE	Sweep Mode - linear RAMP Syntax: "SM1" "SM RAMP"
	2 or —	— TRGL	TRIANGLE	Sweep Mode - linear TRianGLe Syntax: "SM2" "SM TRGL"
	3 or —	— DSCR	DISCRETE	Sweep Mode - DisCRete Syntax: "SM3" "SM DSCR"
SP	0-13 MHz	HZ, KHZ, MHZ	STOP FREQ	StoP frequency Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "SP7.125MHZ"
SPAN	0-13 MHz	HZ, KHZ, MHZ	SPAN	sweep frequency SPAN Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "SPAN10.125MHZ"
SPE	0-1 or —	— OFF, ON	CH A	Synchronous Phase modulation External Syntax: "SPE1" "SPE ON"
SQR	—	—	none	suffix for SQuaRe wave function
SRE	—	—	RESET SWP	Sweep REset Syntax: "SRE"
SS	—	—	SINGLE	Sweep Single Syntax: "SS"

ST	0-13 MHz	HZ, KHZ, MHZ	START FREQ	STart frequency Resolution: 1 μHz < 100 kHz 1 mHz > = 100 kHz Syntax: "ST3.5KHZ"
STC	—	—	none	Sweep on Trigger - Continuous Syntax: "STC"
STIM	5 ms-1000 s	SEC, MS	TIME	Sweep TIMe Resolution: 1 mS Syntax: "STIM.3S"
STS	—	—	none	Sweep on Trigger - Single Syntax: "STS"
TDN	—	—	none	Trigger DowN increment by EINC amount Syntax: "TDN"
TOFF	—	—	none	Trigger OFF Syntax: "TOFF"
TRGL	—	—	suffix	TRianGLe sweep mode
TST	—	—	SELF TEST	self TeST Syntax: "TST"
TUP	—	—	none	Trigger UP increment by EINC amount Syntax: "TUP"
TWOC	—	—	none	suffix for TWO Channel mode
TWOP	—	—	none	suffix for TWO Phase mode
TWOT	—	—	none	suffix for TWO Tone mode
UP	—	—	none	UP increment by EINC value Syntax: "UP"
VO	—	—	units	VOlts peak-to-peak for amplitude. VOlts dc for dc offset.
VRMS	—	—	units	Volts RMS for amplitude
WAIT	—	—	none	no operation Syntax: "WAIT"
ZPH	—	—	ASGN ZERO ϕ	Zero PHase Syntax: "ZPH"

APPENDICES

APPENDIX A

ERROR MESSAGES AND CODES

The HP 3326A error messages and codes provide information on the operating status of the HP 3326A, and help to establish a setup. Many of the messages and codes exist because of the extensive calibration and self test routines incorporated into the HP 3326A and will not appear during normal operation.

ERROR MESSAGE	CODE	DESCRIPTION
SNTX	10	(HP-IB SyNTaX) An HP-IB command has a syntax error or contains illegal characters. Check program controlling the HP 3326A.
RMOT	11	(ReMOTe) A front panel key is pressed while the HP 3326A is in remote. Return the HP 3326A to local.
LOCK	12	(local LOCKout) The LOCAL key is pressed while the HP 3326A is in local lockout. Disable local lockout and return the HP 3326A to local.
RNGE	20	(RaNGE) Value entered for the selected parameter exceeds the valid limits. Check range limits for last operation:

Frequency

— greater than 13 MHz (13.1 MHz for channel B in 2 TONE mode)

Amplitude

— less than 1 mVpp or greater than 10 Vpp without high voltage option

— less than 4 mV or greater than 40 Vpp with high voltage option enabled

— greater than 10 Vpp with high voltage option disabled

— greater than one half the normal limits with combined operation enabled

— greater than 5 Vpp with amplitude modulation enabled on channel A

— amplitude incompatible with dc offset

NOTE

Amplitude limits for combined operation, amplitude modulation, dc offset, and high voltage option are interdependent. Check the limits for the combination of combined operation, amplitude modulation, dc offset, or high voltage functions selected.

DC Offset

— exceeds ±20 V with high voltage option enabled

— exceeds ± 5 V without high voltage option

— dc offset incompatible with amplitude

— invalid with combined operation and sine wave or square wave functions

Phase Duty cycle

— exceeds ±1440°

— less than 1% or greater than 99%

— resulting pulse width less than 20 ns

— during sweep, pulse width less than 20 ns

Modulation level

— less than 0% or greater than 100%

— less than 0° or greater than 360°

Sweep time

— less than 5 ms or greater than 1000 seconds

Bus address

— greater than 30

EINC value

— less than minimum resolution for parameter modified (HP-IB)

— exceeds maximum value for parameter modified (HP-IB)

— units scale EINC value to less than minimum or maximum values (HP-IB)

SRQ MASK range

— greater than 255 (HP-IB)

FCNA or FCNB range

— not equal to 0, 1, 2, or 3 (HP-IB)

MODE range

— not equal to 1, 2, 3, or 4 (HP-IB)

SM range

— not equal to 1, 2, or 3 (HP-IB)

CMD range

— not equal to 1, 2, or 3 (HP-IB)

BUSM range

— not equal to 1 or 2 (HP-IB)

RNGE 21

(RaNGE) In the 2 TONE mode, the channel B offset frequency is greater than 100 kHz. Check the channel B frequency, start frequency, or stop frequency.

RNGE	23	(RaNGE) For a discrete save operation, the discrete frequency sweep element number is nonsequential with existing discrete frequency elements. For an instrument state save operation, the memory selected breaks the continuity of discrete frequency sweep elements. Instrument state saves can only replace the lowest memory location currently used by discrete frequency sweep elements.
RNGE	24	(RaNGE) The requested marker frequency is outside, or at the sweep span. The marker frequency is accepted and this message is displayed to indicate that a marker will not be generated.
RNGE	25	(RaNGE) A frequency value greater than 1 MHz is requested with the high voltage option active. Reduce the frequency value or disable the high voltage option.
RNGE	26	(RaNGE) A channel B frequency value greater than 5 kHz is requested with internal PM active or greater than 100 kHz with internal AM active. Reduce the frequency value or disable internal modulation.
B FR	30	(B FRequency) Channel B frequency in 2 TONE mode cannot track change to channel A frequency because the high voltage option is active. Check that the change to channel A frequency does not cause the channel B frequency to exceed 1 MHz.
INTR	40	(INTeRrogate) A parameter is interrogated over the HP-IB that does not have an interrogation response. Check HP-IB command structure.
INTR	46	(INTeRrogate) The channel B amplitude or offset is selected as the display value when internal modulation is enabled. Channel B amplitude is controlled by the %AM/PM DEV key when internal modulation is enabled.
INTR	47	(INTeRrogate) The channel B phase is selected as the display value when the PULSE mode is enabled. Select alternate entry or change modes.
CNVT	50	(CoNVerTs) The units conversion requested results in a zero display value. For example, converting 0.000001 Hz to MHz would change frequency to dc.
SUFX	60	(SUFfiX) The units key or HP-IB suffix used is improper for the parameter selected. Check consistency of units and parameters.
SUFX	65	(SUFfiX) The high voltage output option is enabled and dBm is selected as units. Change units used for the high voltage option to dBV, VOLTS, or Vrms.
INC	70	(INCrement) The increment value or units used over the HP-IB is incompatible with the displayed value. Check program controlling the HP 3326A.
AMPL	80	(AMPLitude) Combined operation is selected but not enabled because the current amplitude value is too large. Reduce amplitude before selecting combined operation.

MODL	86	(MODuLation) Combined operation is selected but not enabled because Internal AM or PM is enabled. Disable internal modulation prior to selecting combined operation.
MODE	87	(MODE) The requested operation or function is incompatible with the mode selected. Select alternate mode for operation required. 2 CHANNEL mode — synchronous PM is selected but not enabled 2 PHASE or 2 TONE mode — internal AM or PM is selected but not enabled — external PM is selected but not enabled PULSE mode — sine wave or dc only output is selected but not enabled (HP-IB) — combined operation is selected but not enabled — zero phase cannot be assigned to channel B — channel B phase offset cannot be cleared — internal AM or PM is selected but not enabled — external PM is selected but not enabled
FREQ	88	(FREQuency) Channel B frequency is greater than 5 kHz and internal PM is selected, or the channel B frequency is greater than 100 kHz and internal AM is selected. Internal PM or AM is not enabled. Change the channel B frequency prior to enabling modulation.
CMBR	89	(CoMBineR) Combined operation is enabled and AM or PM is selected. AM or PM is not enabled. Disable combined operation prior to selecting modulation.
SWFR	90	(SWeep FRequency) The start and stop frequencies are equal for both channels and a frequency sweep is enabled. This message appears as an advisory that the HP 3326A will not appear to sweep. If a frequency sweep is desired, change the start or stop frequencies.
DUTY	94	(DUTY cycle) The duty cycle of a PULSE is too narrow for a sweep. Reduce the start or stop frequency or, in the PULSE mode, change the duty cycle.
SWFR	95	(SWeep FRequency) The high voltage option is enabled and a frequency sweep start or stop frequency is greater than 1 MHz. Disable the high voltage option or decrease the sweep start or stop frequency.
SWFR	96	(SWeep FRequency) The channel B frequency exceeds the 5 kHz internal PM limit or exceeds the 100 kHz internal AM limit during a sweep. Disable internal modulation or decrease the sweep start or stop frequency.

RATE	100	(RATE) The sweep rate is less than 5 mHz/s or greater than 0.5 MHz/ms. For sweep rates less than 5 mHz/s, decrease the sweep time or increase the difference between the start and stop frequencies. For sweep rates greater than 0.5 MHz/ms, increase the sweep time or decrease the difference between the start and stop frequencies.
DSWP	110	(Discrete frequency SWeeP) A discrete frequency sweep is invalid because no discrete frequency elements are saved in memory. Enter discrete frequency elements (the channel A and B frequencies, and dwell time) through the SAVE DISCRETE key starting with element 00.
DSWP	114	(Discrete frequency SWeeP) A frequency is too high for the duty cycle requested during a discrete frequency sweep. Reduce the discrete frequency sweep element frequency or, in PULSE mode, change the duty cycle.
DSHV	115	(Discrete Sweep High Voltage) The high voltage option is enabled and a discrete frequency element frequency exceeds 1 MHz. Disable the high voltage option or reduce the discrete frequency sweep element frequency.
DSML	116	(Discrete Sweep ModuLation) The channel B frequency exceeds the 5 kHz internal PM limit or exceeds the 100 kHz internal AM limit during a discrete frequency sweep. Reduce the discrete frequency sweep element frequency or disable modulation.
DSMD	117	(Discrete Sweep MoDe) The discrete frequency sweep elements in memory are incompatible with the mode selected. For example, discrete frequency elements entered in 2 PHASE mode and current mode is 2 TONE. Change the HP 3326A mode, or enter new discrete frequency elements.
P OF	120	(Phase OFfset) The phase offset of channel A cannot be cleared.
H V	130	(High Voltage) The high voltage option is not installed and high voltage is selected.
H V	136	(High Voltage) Channel B high voltage option is selected when internal modulation is enabled. Disable internal modulation prior to enabling high voltage option.
H V	138	(High Voltage) Channel A or channel B high voltage option is selected when the frequency is greater than 1 MHz. Reduce the channel A or B frequency.
CSUM	140	(CheckSUM) A checksum error is detected during a recall, HP-IB learn, or HP-IB program operation. For HP-IB operation, check HP-IB cables, and that instrument state data saved external to the HP 3326A has not changed.
—	150	The current instrument configuration is incompatible with the state recalled or programmed.
CRPT	160	(CoRruPT) An error is detected in an instrument state at power up. The corrupt instrument state is replaced with the preset state.

A OL	170	(A OverLoad) Channel A output is overloaded. The load impedance for the channel A output is too low, or a voltage source is attached to the channel A output.
B OL	171	(B OverLoad) Channel B output is overloaded. The load impedance for the channel B output is too low, or a voltage source is attached to the channel B output.
SYOL	172	(SYnc OverLoad) The SYNC A output is overloaded. The load impedance attached to the SYNC A output is too low, or a voltage source is attached to the SYNC A output.
AVCO	173	(channel A Voltage Controlled Oscillator) The channel A voltage controlled oscillator is unlocked. This indicates a hardware failure if the message persists.
BVCO	174	(channel B Voltage Controlled Oscillator) The channel B voltage controlled oscillator is unlocked. This indicates a hardware failure if the message persists.
XREF	180	(eXternal REFerence) An external reference signal is available but the HP 3326A cannot lock to it. Check the frequency, level, and stability of the reference signal.
MCAL	190	(Modulation CALibration) An internal AM or PM calibration is unsuccessful and the HP 3326A is unable to calibrate internal circuits. If this message occurs after the HP 3326A is fully warmed-up (30 minutes of operation), the HP 3326A may require repair or adjustment to meet specifications.
PCAL	191	(Phase CALibration) A phase calibration is unsuccessful and the HP 3326A is unable to calibrate internal circuits. If this message occurs after the HP 3326A is fully warmed-up (30 minutes of operation), the HP 3326A may require repair or adjustment to meet specifications.
ACAL	192	(Amplitude CALibration) An amplitude calibration is unsuccessful and the HP 3326A is unable to calibrate internal circuits. If this message occurs after the HP 3326A is fully warmed-up (30 minutes of operation), the HP 3326A may require repair or adjustment to meet specifications.
OCAL	193	(Offset CALibration) A dc offset calibration is unsuccessful and the HP 3326A is unable to calibrate internal circuits. If this message occurs after the HP 3326A is fully warmed-up (30 minutes of operation), the HP 3326A may require repair or adjustment to meet specifications.
OCAL	194	(Offset CALibration) A residual dc offset calibration is unsuccessful and the HP 3326A is unable to calibrate internal circuits. If this message occurs after the HP 3326A is fully warmed-up (30 minutes of operation), the HP 3326A may require repair or adjustment to meet specifications.
PASS	—	A self test has completed successfully.
FAIL	—	A self test is unsuccessful. This indicates a hardware failure if the message persists.

APPENDIX B

SPECIFICATIONS

Unless otherwise stated, the following specifications apply to the Channel A and Channel B outputs in all modes, with the internal combiner and all modulation off, and outputs terminated in 50 ohms. For tabular data, specifications apply at and above the stated frequency or amplitude range.

Specifications describe the instrument's warranted performance after a warm-up period of 30 minutes (except where noted). SUPPLEMENTAL CHARACTERISTICS are intended to provide information useful in applying the instrument by giving typical, but non-warranted, performance parameters. Supplemental characteristics are denoted as *typical, nominal,* or *approximate.*

MODES

TWO-CHANNEL: Channels A and B are independent.

TWO-PHASE: Channels A and B are the same frequency, with a calibrated phase difference between them.

TWO-TONE: Channel B frequency must be within 100 kHz of the Channel A frequency.

PULSE: Channel B is the complement of the Channel A output.

WAVEFORMS

Sine, Square, Pulse and DC.

FREQUENCY

RANGE: DC to 13 MHz.

RESOLUTION: 1 μHz below 100 kHz, 1 mHz at or above 100 kHz.

ACCURACY: $\pm 5 \times 10^{-6}$ of selected value, 20°C to 30°C, at time of frequency reference calibration with standard instrument.

STABILITY: $\pm 5 \times 10^{-6}$/year, 20°C to 30°C, with standard instrument.

MAIN SIGNAL OUTPUTS (Channels A and B, all waveforms unless noted)

IMPEDANCE: 50Ω ± 1Ω, DC to 100 kHz.

RETURN LOSS: >20 dB, 100 kHz to 13 MHz.

CHANNEL ISOLATION: >80 dB below the larger signal, or < −90 dBm, whichever is greater, 10 Hz to 13 MHz, sine wave only, Two-Channel and Two-Tone modes. For square wave and DC, *typically* >80 dB to 5 MHz, *typically* >65 dB to 13 MHz.

CONNECTOR: Front panel BNC (rear panel if Option 003).

FLOATING: Both outputs share the same ground and may be floated up to ±42 V peak (AC & DC).

AC AMPLITUDE (All Waveforms)

RANGE (WITHOUT DC OFFSET):

Units Displayed	Function: Sine min	Sine max	Square & Pulse min	Square & Pulse max
peak-to-peak	1.000 mV	10.00 V	1.000 mV	10.00 V
rms	0.354 mV	3.54 V	0.500 mV	5.00 V
dBm(50Ω)	−56.02	+23.98	−53.01	+26.99
dBV	−69.03	+10.97	−66.02	+13.98

RESOLUTION: 4 digits, or approximately 0.1% of value for peak-to-peak entry, 0.3% of value for rms entry, and 0.01 dB for dBm or dBV entry.

ACCURACY: Relative to selected value after performing self-calibration.

Sine Wave:

	0.001 Hz	100 kHz	1 MHz	13 MHz
+23.98 dBm	±0.1 dB	±0.3 dB		±0.6 dB
+3.98 dBm				±0.8 dB
−36.02 dBm	±0.2 dB	±0.5 dB		±1.0 dB
−56.02 dBm				

Square Wave and Pulse (5 to 95% duty cycle):

	0.001 Hz	100 kHz	1 MHz	13 MHz
10.00 Vpp	±2.0%	±3.0%		±6.0%
1.00 Vpp		±5.0%		±8.0%
100 mVpp				

WAVEFORM CHARACTERISTICS

SINE WAVE SPECTRAL PURITY:

Harmonic Distortion: Harmonically related signals will be less than the following levels relative to the fundamental, or < −90 dBm, whichever is greater.

	10 Hz	50 kHz	100 kHz	1 MHz	13 MHz
+23.98 dBm	−80 dBc	−70 dBc	−55 dBc		−30 dBc
+13.98 dBm	−80 dBc	−80 dBc	−65 dBc		−50 dBc
−56.02 dBm					

Spurious: In Two-Channel mode, all non-harmonically related output signals (10 Hz* to 40 MHz) will be less than the following levels relative to the fundamental, or < −90 dBm, whichever is greater.

Channel Frequency	Spurious Level
10 Hz to 1 MHz	−80 dBc
1 MHz to 13 MHz	−70 dBc

*Ground isolation must be maintained.

Integrated Phase Noise: For a 30 kHz band centered on a 10 MHz carrier (excluding ±1 Hz about the carrier).

With option 001: < −63 dBc.

With standard instrument: *typically* < −60 dBc.

SQUARE WAVE AND PULSE CHARACTERISTICS:

Rise/fall time: ≤15 ns 10% to 90% at full output at 1 MHz.

Overshoot: ≤5% of peak-to-peak amplitude at full output at 1 MHz.

Square Wave symmetry: ≤ ± 1% of period + 6ns.

Pulse Width range: 1% to 99% of period or 20 ns, whichever is greater.

Pulse Width resolution: 0.1% of period.

Pulse Width accuracy: ≤ ± 1% of period ± 20 ns.

DC ONLY

RANGE: 0 to ±5.0 V.

RESOLUTION: 3 digits or 10 mV.

ACCURACY (AFTER PERFORMING SELF-CALIBRATION): ± 75 mV.

SPECIFICATIONS

DC OFFSET

RANGE: Maximum DC Offset is a function of the selected AC amplitude.

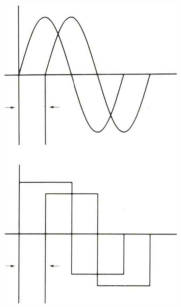
AC Amplitude	Max AC + DC	Max DC Offset
1.0 to 10.0 Vpp	± 5.0 V	± 4.5 V
0.1 to 1.0 Vpp	± 0.5 V	± 0.45 V
10 mV to 100 mVpp	± 50 mV	± 45 mV
1 mV to 10 mVpp	± 5 mV	± 4.5 mV

RESOLUTION: 4 digits.

DC ACCURACY (AFTER PERFORMING SELF-CALIBRATION):

	Mode	
	Sine Wave	Square Wave/Pulse*
10 Hz to 1 MHz	± 2.0% of max DC	± 2.0% of max DC
1 MHz to 13 MHz	± 5.0% of max DC	± 6.0% of max DC

* midpoint between peaks



PHASE OFFSET

The following specifications apply to the Phase Offset between Channels A and B in the Two-Phase mode only. Phase is defined as the difference in rising edge to rising edge (using the midpoint as the reference point) for sine and square waves.

RANGE: ± 720°.

RESOLUTION: 0.01°.

ABSOLUTE ACCURACY: in degrees with the following output waveforms on Channels A and B, equal amplitude levels, and either internal phase calibration or external phase calibration (using a power splitter and equal length cables).

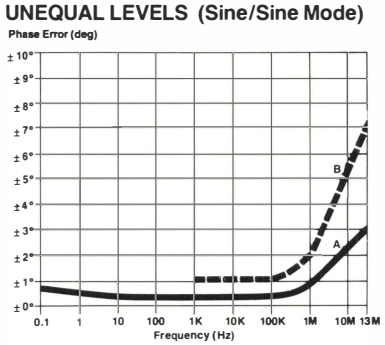
Sine/Sine Outputs:

Cal Mode	0.1 Hz	10 Hz	1 kHz	100 kHz	1 MHz	13 MHz
Internal[1]	± 0.5°	± 0.2°	± 0.2°	± 0.3°	± 2.0°	
Internal[2]	± 0.8°	± 0.4°	± 0.4°	± 0.5°	± 3.0°	
External[1]	N/A		± 0.2°	± 0.3°	± 2.0°	

1 = At amplitude levels between 1 V to 10 Vpp (+ 3.98 to + 23.98 dBm).
2 = At amplitude levels between 0.1V to 10 Vpp (– 16.02 to + 23.98 dBm).

Typical performance

UNEQUAL LEVELS (Sine/Sine Mode)



A.) Unequal Levels, Internal Cal.[1]
B.) Unequal Levels, External Cal.[1]

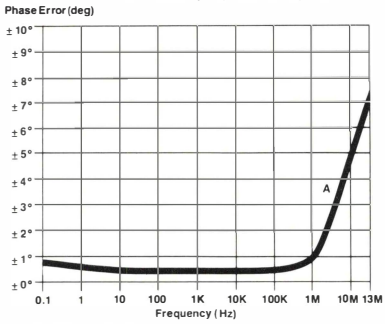
Square/Square Outputs:

Cal Mode	0.1 Hz	10 Hz	1 kHz	100 kHz	1 MHz	13 MHz
Internal[1]	± 0.5°	± 0.2°	± 0.2°	± 0.7°	± 5.0°	
Internal[2]	± 0.8°	± 0.4°	± 0.4°	± 1.0°	± 7.0°	
External[1]	N/A		± 0.2°	± 0.7°	± 5.0°	

1 = At amplitude levels between 1 V to 10 Vpp (+ 3.98 to + 23.98 dBm).
2 = At amplitude levels between 0.1V to 10 Vpp (– 16.02 to + 23.98 dBm).

Typical Performance

UNEQUAL LEVELS (Square/Square Mode)



A.) Unequal Levels, Internal Cal.[1]

STABILITY WITH TEMPERATURE: *typically* ± 0.3° phase/°C, 20°C to 30°C.

STABILITY WITH TIME: *typically* ± 0.1°/10 min after a 30 min warm-up, ± 0.02°/10 min after a 1 hr warm-up.

AMPLITUDE MODULATION

The following specifications apply to the Channel A and Channel B outputs with external modulation or to the Channel A output with internal modulation (Channel B is the modulation source). External amplitude modulation is allowed in any mode while internal amplitude modulation is allowed only in the Two-Channel mode.

WAVEFORMS: Sine, square, or pulse (pulse allowed in external only).

CARRIER FREQUENCY RANGE: DC to 13 MHz.

MODULATION FREQUENCY RANGE: DC to 100 kHz.

MODULATION DEPTH: 0 to 100%.

The following specifications apply at 10 MHz carrier frequency, 1 kHz modulation source, 80% modulation depth.

Envelope Distortion: < – 46 dB.

Incidental PM: ≤5° peak.

Modulation Index Accuracy (internal only): ± 5% of setting

Modulation Index Resolution (internal only): 0.1%.

EXTERNAL MODULATION:

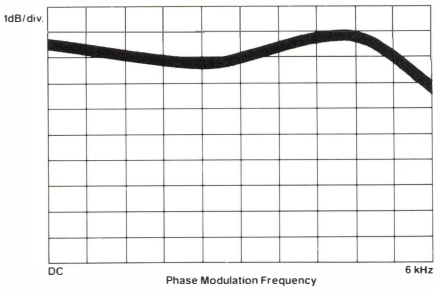
Channel A sensitivity: *approximately* – 1.0 V for 0%, + 1.0 V for 100%.

Channel B sensitivity: *approximately* + 1.0 V for 0%, – 1.0 V for 100%.

Input impedance: 10 KΩ nominal.

SPECIFICATIONS

Typical Amplitude Response



PHASE MODULATION

The following specifications apply to the Channel A and Channel B outputs with external and synchronous phase modulation, and to the Channel A output with internal phase modulation (Channel B is the modulation source). External and synchronous PM are allowed in any mode while internal PM is allowed only in the Two-Channel mode.

WAVEFORMS: Sine, square, or pulse (pulse allowed in external only).

CARRIER FREQUENCY RANGE: DC to 13 MHz.

MODULATION FREQUENCY RESPONSE: DC to 200 Hz: ±0.5dB
DC to 5kHz: −3dB see typical plot

PHASE DEVIATION: ±360°.

LINEARITY: ±0.5%, best fit straight line.

DISTORTION (10 MHz CARRIER FREQUENCY, 1 kHz MODULATION SOURCE):
≤ −50 dBc for less than ±45° peak deviation,
≤ −37 dBc at ±90° peak deviation

INTERNAL MODULATION:
Phase deviation resolution: 1°.

Phase deviation accuracy: 5% of setting

EXTERNAL AND SYNCHRONOUS MODULATION:
Sensitivity: *approximately* 360°/V.
Input impedance: 3 KΩ nominal.

Incidental AM: <0.5% at 360° peak deviation

FREQUENCY SWEEP

SWEEP TYPES:
Linear sweep: User selectable Start/Stop Frequencies and Sweep Time.

Discrete sweep: 1 to 63 user selectable sequential elements. Each element consists of Channel A and B frequencies and the dwell time before switching to the next element.

LINEAR SWEEP:
Sweep forms: Triangle, ramp.

Sweep time: 5 ms to 1000 s, limited to 5 mHz/s to 500 MHz/s sweep rates.

Sweep Width: 25 µHz to 13 MHz.

DISCRETE SWEEP DWELL TIME: 5 ms to 1000 s between switching elements, limited to 5 mHz/s to 500 MHz/s sweep rates.

PHASE CONTINUITY: Sweep is phase continuous over the full frequency range.

OUTPUT COMBINER

The following specifications apply when Channel A and B are combined on the Channel A output with the Channel B output automatically turned off and terminated in 50Ω. The combiner may be used in the Two-Channel, Two-Phase and Two-Tone modes only. DC offset is automatically set to 0 V when the combiner is on.

FREQUENCY RANGE: DC to 13 MHz.

RETURN LOSS: >20 dB.

AMPLITUDE: The maximum settable levels of Channels A and B are each reduced by 6.02 dB.

AMPLITUDE ACCURACY: Add the following to the amplitude accuracy of Channel A or B, given on page 10.

DC to 100 kHz	±0.1 dB
100 kHz to 13 MHz	±0.3 dB

INTERMODULATION DISTORTION: In Two-Tone mode, third-order intermodulation products will be less than the following levels relative to the higher of the fundamentals. Both channels must be in the indicated frequency band with a minimum frequency separation of 10 Hz.

	10 Hz	1 MHz	13 MHz
+17.96 dBm			
+ 7.98 dBm		− 70 dB	− 45 dB
− 56.02 dBm		− 80 dB	− 65 dB

AUXILIARY OUTPUTS

SYNC A: Square Wave with the same frequency as Channel A.

Level: $V_{high} \geq 1.2$ V, $V_{low} \leq 0.2$ V into 50Ω.

Output impedance: 50Ω nominal.

Connector: Front panel BNC.

X-AXIS DRIVE: Linear ramp proportional to sweep time in linear sweep mode and discrete sweep (if dwell time is <1000 s).

Level: 0 to +10 V DC.

Linearity: ±0.2% between 10% and 90% of ramp.

Accuracy: ±4% of full scale value, >10 KΩ load.

Connector: Rear panel BNC.

Z-AXIS BLANK: TTL compatible level that is low during sweep.

Connector: Rear panel BNC.

SWEEP MARKER: TTL compatible level that makes a high-to-low transition at the selected marker frequency during linear sweep or is low during discrete frequencies, pulsing high for a minimum of 10 µs between frequency changes.

Connector: Rear panel BNC.

10 MHz REFERENCE: > +3 dBm output for frequency-locking additional instruments to the 3326A.

Impedance: 50Ω nominal.

Connector: Rear panel BNC.

10 MHz OVEN OUTPUT (OPTION 001 ONLY): > +3 dBm internal high stability frequency reference output for phase-locking other instruments.

Connector: Rear panel BNC.

20 − 33 MHz LO OUTPUT: ≥100 mV square wave output that is offset 20 MHz from the Channel B output frequency.

Impedance: 50Ω nominal, AC coupled.

Connector: Rear panel BNC.

SPECIFICATIONS

AUXILIARY INPUTS

EXTERNAL REFERENCE INPUT: For phase-locking the 3326A to an external frequency reference. Signal from 0 dBm to +20 dBm into 50Ω. Reference must be 1, 2, 5 or 10 MHz ± 10 ppm. Channel A phase stability with respect to external reference input is ±1% C.

Connector: Rear panel BNC. With option 001 this input must be connected to the 10 MHz Oven Output.

EXTERNAL TRIGGER: TTL compatible level that initiates linear or discrete sweep on high to low transition.

Connector: Rear panel BNC.

CHANNEL A EXTERNAL PHASE CALIBRATION: For external or multiphase calibration.

Frequency range: 1 kHz to 13 MHz.

Amplitude range: 1 to 10 V peak-to-peak.

Impedance: 50Ω nominal.

Waveform: Sine wave or square wave with 50% duty cycle.

Connector: Rear panel BNC.

CHANNEL B EXTERNAL PHASE CALIBRATION: For external or multiphase calibration. Specifications identical to Channel A external phase calibration input.

Connector: Rear panel BNC.

CHANNEL A EXTERNAL AMPLITUDE MODULATION: *See modulation specifications.*

Connector: Rear panel BNC.

CHANNEL B EXTERNAL AMPLITUDE MODULATION: *See modulation specifications.*

Connector: Rear panel BNC.

CHANNEL A EXTERNAL PHASE MODULATION/SYNCHRONOUS PHASE MODULATION: *See modulation specifications.*

Connector: Rear panel BNC.

CHANNEL B EXTERNAL PHASE MODULATION: *See modulation specifications.*

Connector: Rear panel BNC.

SAVE/RECALL MEMORY

Ten non-volatile memory locations.

Front panel setups can be stored in memory locations 1 through 9. Last front panel setup is saved in memory location 0 when power is removed. Use of discrete sweep overwrites memory locations 1 through 9 with the 63 discrete elements, where an element consists of Channel A and B frequencies and the dwell time between elements.

HP-IB CONTROL

CAPABILITY: Compatible with IEEE Standard 488 – 1978. All front panel functions, except line switch and HP-IB address, are programmable. Special HP-IB only functions include Service Requests, diagnostics, device trigger for external trigger, and front panel display secure mode. The 3326A is compatible with most HP 3325A HP-IB mnemonics.

INTERFACE FUNCTIONS: SH1,AH1,T6, L4,SR1,RL1,PP0,DC1,DT1,C0,E1.

TYPICAL SWITCHING TIMES (EXCLUSIVE OF PROGRAMMING TIME):

Frequency (to within ±10ppm):
≤10 ms for a 100 kHz step,
≤25 ms for a 1 MHz step,
≤70 ms for a 10 MHz step.

Phase (to within ±1°): ≤15 ms.

Amplitude (to within amplitude specifications): ≤ 30 ms.

OPTIONS

OPTION 001 HIGH STABILITY FREQUENCY REFERENCE

Improves frequency stability and integrated phase noise characteristics.

STABILITY: $\pm 5 \times 10^{-8}$/week, after 72 hours continuous operation, $\pm 1 \times 10^{-7}$/mo. after 15 days continuous operation.

WARM-UP TIME: Reference will be within $\pm 1 \times 10^{-7}$ of final value 15 minutes after turn-on at 25°C for an off time of 24 hours.

PHASE NOISE: see Sine Wave Spectral Purity section on page 10.

OPTION 002 HIGH VOLTAGE OUTPUT

Increases output level by a factor of 4 and expands the allowable DC offset range. The following specifications apply to the Channel A and Channel B outputs in all modes with the internal combiner off.

FREQUENCY RANGE: DC to 1 MHz.

OUTPUT IMPEDANCE:
DC to 50 kHz: <2Ω.
50 kHz to 1 MHz: <10Ω.

AMPLITUDE:
Range: 4 mV to 40 Vpp into 1 k Ω load with <200 pF, without DC offset. Levels are 4 times the standard instrument ranges. Amplitude is entered in peak-to-peak units only.

Accuracy: ≤ ±12% of peak-to-peak value for sine, square, and pulse for 400 mV to 40 Vpp values.

SINE WAVE HARMONIC DISTORTION: Harmonically related signals will be less than the following levels relative to the fundamental, into 1 K Ω, no DC offset.

	10 Hz	50 kHz	100 kHz	1 MHz
40.00 Vpp	– 75 dB	– 65 dB	– 40 dB	
12.64 Vpp	– 80 dB	– 75 dB	– 55 dB	
400 mVpp				

SPECIFICATIONS

SQUARE WAVE AND PULSE CHARACTERISTICS:
Rise/fall time: ≤150 ns, 10% to 90% at full output with 1 k Ω, 200 pF load.

Overshoot: ≤10% of peak-to-peak amplitude at full output with 1 kΩ, 200 pF load.

DC ONLY AND DC OFFSET CHARACTERISTICS:
DC Only Range: 0 to ± 20 V.
DC Offset Range: ± 20 V independent of the AC amplitude range. DC + AC peak must be less than 20 V.
DC Offset Accuracy: ± 100 mV ± 1% of setting.

OUTPUT COMBINER: The following specifications apply when Channel A and B are combined on the Channel A output (Channel B output is off). The combiner may be used in the Two-Channel, Two-Phase and Two-Tone modes. DC offset is automatically set to 0 V when the combiner is on.

INTERMODULATION DISTORTION: Third-order intermodulation products will be less than the following levels relative to the higher of the fundamentals (sine wave only). Both channels must be in the indicated frequency band with a minimum frequency separation of 10 Hz.:

	10 Hz	100 kHz	1 MHz
20.00 Vpp		– 60 dB	– 40 dB
6.32 Vpp		– 75 dB	– 55 dB
200 mVpp			

MAXIMUM OUTPUT CURRENT: 80 mA peak-to-peak.

OPTION 003 REAR PANEL MAIN SIGNAL OUTPUTS

Replaces front panel Channel A and B outputs with rear panel outputs.

GENERAL

OPERATING ENVIRONMENT:
Temperature: 0°C to 55°C.
Relative Humidity: 95%, 0°C to 40°C.
Altitude: ≤4,572 m (15,000 ft).
STORAGE ENVIRONMENT:
Temperature: – 40°C to + 75°C.
Altitude: ≤15,240 m (50,000 ft).
POWER: 100/120/220/240V, + 5%, – 10%; 48 to 66 Hz; 120 VA, 150 VA with all options, 10 VA standby.
WEIGHT: 27 kg (60 lbs.) net, 37 kg (81 lbs.) shipping.
DIMENSIONS: 177 mm H x 425.5 mm W x 497.8 mm D (7″ x 16 – 3/4″ x 19 – 5/8″).

ACCESSORIES INCLUDED:

1 ea. Operating Manual (HP Part Number 03326 – 90000). 1 ea. Service Manual (HP Part Number 03326 – 90010).

ACCESSORIES AVAILABLE:

15507A Ground Isolator for breaking signal grounds between input and output connectors, thereby isolating a connector from the chassis ground.

11048C 50 Ohm Feed Thru Termination for terminating outputs in 50Ω.

11652 – 60009 50 Ohm BNC Power Splitter. 11667A 50 Ohm Type N Power Splitter for use in external and multiphase calibration.

03326 – 84401 Service Accessory Kit for trouble-shooting and repair of the 3326A. Includes extender boards and cables.

9211 – 2656 Transit Case for rugged protection, transportation, and storage.

RELATED EQUIPMENT

1980B Oscilloscope Measurement System (DC to 100 MHz)

3561A Dynamic Signal Analyzer (125 μHz to 100 kHz)

3585A Spectrum Analyzer (20 Hz to 40 MHz)

3586C Selective Level Meter (50 Hz to 32.5 MHz)

ORDERING INFORMATION:

		USA List Prices Only
3326A Two-Channel Synthesizer		$9,200
Option 001 High Stability Frequency Reference (to retrofit order HP Part Number 03326-88801)	add	650
Option 002 High Voltage Output (to retrofit order HP Part Number 03326-88802)	add	300
Option 003 Rear Panel Main Signal Outputs (to retrofit order HP Part Number 03326-88803)		N/C
Option 907 Front Handle Kit (to retrofit order HP Part Number 5061-0090)	add	60
Option 908 Rack Flange Kit (to retrofit order HP Part Number 5061-0078)	add	35
Option 909 Rack Flange and Front Handle Kit (to retrofit order HP Part Number 5061-0084)	add	90
Option 910 Extra Operating Manual	add	100
Option 914 Delete Service Manual	less	115
15507A Ground Isolator		275
11048C 50 Ohm Feed Thru Termination		30
9211-2656 Transit Case		540
03326-84401 Service Accessory Kit		250

APPENDIX C

QUICK REFERENCE

This quick reference foldout contains abbreviated operating information for the HP 3326A. Included in this section is a brief description of the HP 3326A front and rear panels.

1 MODULATION INPUTS

A-AMPTD MOD IN and **B-AMPTD MOD IN** connectors provide the input to externally modulate the amplitude of the channel A and B outputs (100 kHz maximum modulation frequency). 1 Vdc (-1 Vdc for channel B) corresponds to 100% modulation.

A-PHASE MOD IN/SYNC PM IN and **B-PHASE MOD IN** connectors provide the input to externally phase modulate the channel A and B outputs (5 kHz maximum modulation frequency). ±1 Vdc corresponds to ±360° modulation.

2 CALIBRATION INPUTS

A-EXT PHASE CAL IN and **B-EXT PHASE CAL IN/ MULTI ϕ REF IN** connectors allow the HP 3326A to sense phase externally for an external or multiphase calibration. These inputs require a 1 kHz to 13.1 MHz signal with an amplitude of 3 to 10 Vpp.

3 CHANNEL OUTPUTS

CH A OUT OPT 003 and **CH B OUT OPT 003** are optional rear panel outputs for channel A and B.

4 FREQUENCY REF INPUT/OUTPUT

1, 2, 5, 10 MHz REF IN connector allows the HP 3326A to phase-lock to a stable frequency reference. This input is referenced to chassis ground.

10 MHz OUT connector provides 10 MHz square wave (<3 dBm 50 Ω) as a frequency reference for other instruments. This output is referenced to chassis ground.

10 MHz OVEN OUTPUT Option 001 provides a high stability frequency reference when connected to 1, 2, 5, 10 MHz REF IN. The 10 MHz OVEN OUTPUT is a square wave (< 3 dBm 50 Ω). This output is referenced to chassis ground.

5 20-33 MHz B-L.O. OUTPUT

20-33 MHz B-L.O. OUTPUT provides an output offset from the channel B frequency by 20 MHz. This output is referenced to chassis ground.

6 MARKER OUT

MARKER OUT TTL level signal provides a negative going transition at the frequency entered with the MKR FREQ key.

7 EXT TRIG INPUT

EXT TRIG IN allows external triggering of sweeps on negative edge transition of a TTL signal.

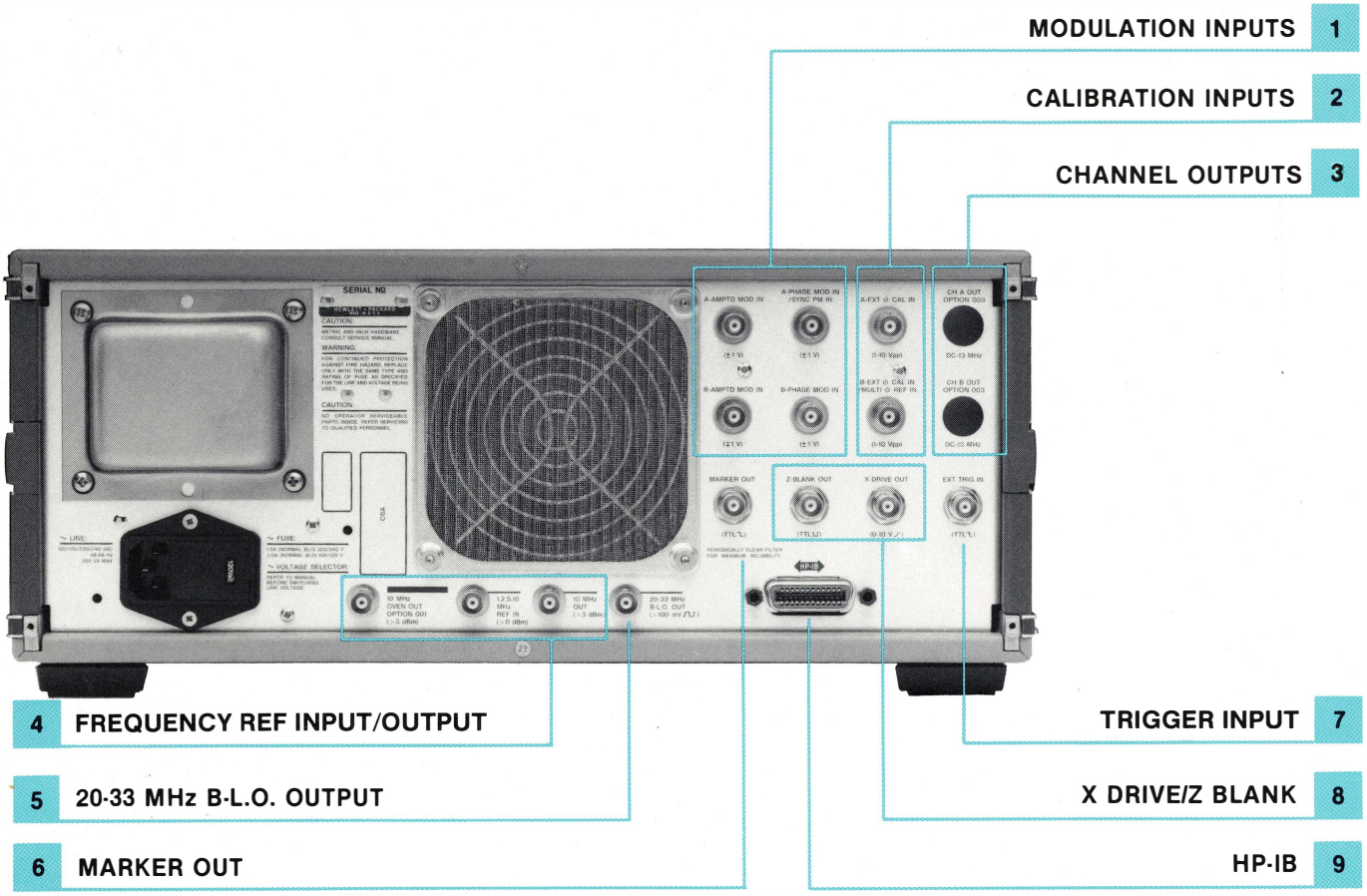
8 X-DRIVE/Z-BLANK OUTPUTS

X-DRIVE provides linear 0 to <10 V ramp proportional to sweep time.

Z-BLANK TTL output drops low at start of sweep during frequency sweeps, capable of sinking current (100 mA maximum) from a positive source.

9 HP-IB

HP-IB connector allows remote operation of the HP 3326A with an external controller. This connector is referenced to chassis ground.



APPENDIX C

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1 STATUS

Display panel displays frequency (up to 11 digits), amplitude, phase offset, dc offset, sweep frequencies and time, marker frequency, and HP-IB address values, as well as error messages.

CHAN key selects channel for display and modification.

CH A and **CH B** indicators indicate channel selected for display and modification.

HV-A and **HV-B** indicators illuminate when the high voltage option is enabled.

ϕ **OFFSET** indicator illuminates when a phase offset exists for channel B relative to channel A.

EXT REF indicator illuminates when the HP 3326A is operating with an external frequency reference or high stability frequency option (Option 001).

2 DATA

Frequency, amplitude, offset, time, phase, duty cycle, modulation level, memory location, and HP-IB address values are entered with the numeric keypad followed by a units suffix.

BACK SP key removes the least significant digit from the display during data entry.

3 HP-IB STATUS

REMOTE, **LISTEN**, **TALK**, and **SRQ** status indicators provide an indication of HP-IB operation.

LOCAL key switches HP 3326A control from remote operation to front panel operation unless local lockout is in effect.

BUS ADRS key enables display or modification of the HP-IB address stored in nonvolatile memory.

4 SWEEP

CONT and **SINGLE** keys select either continuous or single frequency sweeps. During discrete frequency sweeps, the SINGLE key steps through the sweep elements.

START FREQ and **STOP FREQ** keys allow entry or modification of the frequency sweep start and stop frequencies.

MKR→CF key centers the sweep span around the marker frequency.

CNTR FREQ and **SPAN** keys allow entry or modification of the frequency sweep start and stop frequencies in terms of sweep center frequency and sweep span.

MKR FREQ key allows entry or modification of a marker frequency.

TIME key allows entry or modification of the frequency sweep sweep time. For discrete frequency sweeps, time is the dwell time for each discrete frequency sweep element.

RESET SWEEP key resets the frequency sweep circuits.

TRIANGLE key selects triangle (indicator illuminated) or ramp (indicator extinguished) linear frequency sweeps. The ramp sweep function sweeps from start to stop frequency, while the triangle sweep function sweeps from start to stop to start frequencies.

DISCRETE key enables discrete frequency sweeps (frequency hopping). Discrete frequency sweeps sequence through the discrete frequency sweep elements stored with the SAVE DISCRETE key.

5 ENTRY

FREQ key allows entry or modification of frequency values.

AMPTD key allows entry or modification of amplitude values.

DUTY CYCLE key allows entry or modification of the square wave duty cycle.

% AM/PM DEV key allows entry or modification of percent of AM modulation or PM deviation.

PHASE key allows entry or modification of phase values.

DC OFFSET key allows entry or modification of dc offset values.

ASGN ZERO ϕ key assigns a zero value to phase offset without changing the phase of the output.

CLR ϕ **OFS** key restores the channel B phase offset value without changing the phase of the output.

6 INSTR STATE

INSTR PRESET key sets the following setup:

Mode	2 CHANNEL
Combined operation	Off
Frequency A and B	1000 Hz
Amplitude A and B	100 mVpp
Phase	0°
Duty cycle	50 %
DC offset A and B	0 V
Modulation	Off
Modulation level	30%
Sweep	Off
	Ramp
	13 MHz span
	1 s sweep
	6.5 MHz marker
Function A and B	Sine wave
High voltage	Off
Calibration	Internal
Autocalibration	Off

SAVE and **RECALL** keys save and recall setups from nonvolatile memory registers 0 – 9. Register 0 contains the last setup prior to removing power.

CLR DISCRETE key erases all discrete frequency sweep elements stored in memory.

7 POWER/SHIFT

POWER KEY applies power to the entire HP 3326A when ON (depressed). In STBY, power is applied only to the high stability frequency reference option (Option 001) when the HP 3326A is connected to a suitable power source.

CLEAR MEM key clears the contents of internal memory if the key is held down when power is applied.

SHIFT key enables the front panel keys to select the alternate functions printed in blue.

8 MODIFY

Rotary knob modifies frequency, amplitude, phase, offset, duty cycle, modulation level and time values when enabled by arrow keys or ON key.

← and → keys enable the rotary knob and select display (flashing) digit modified.

ON/OFF key enables and disables the modify function and flashing digit.

9 MODULATION

Modulation keys select internal and external AM and PM sources. Internal modulation uses channel B to modulate channel A. External modulation inputs are on the rear panel.

INT AM, **INT PM**, **EXT AM**, **EXT PM**, and **(AB) SYNC PM** indicators illuminate to indicate the type of modulation selected with the modulation keys.

10 CALIBRATION

MANUAL key initiates an HP 3326A calibration.

AUTO key enables automatic calibration.

INTERNAL, **EXTERNAL**, and **MULTIPHASE** indicators illuminate to indicate the phase calibration source selected with the SELECT key.

SELECT key selects the HP 3326A phase calibration source. Multiphase and external phase calibration inputs are on the rear panel.

SELF TEST key initiates a self test.

11 MODE

MODE key selects the 2 CHANNEL, 2 PHASE, 2 TONE, or PULSE operating modes. The 2 CHANNEL mode provides two independent sources, the 2 PHASE mode provides two tracking sources with a phase offset, the 2 TONE mode provides two tracking sources with a frequency offset, and the PULSE mode provides a pulse signal and its complement.

2 CHANNEL, **2 PHASE**, **2 TONE**, or **PULSE** indicators illuminate to indicate the the mode selected.

COMBINED key combines channel A and B to produce a composite output at channel A.

12 FUNCTION

CH A and **CH B** keys select the function outputs for each channel.

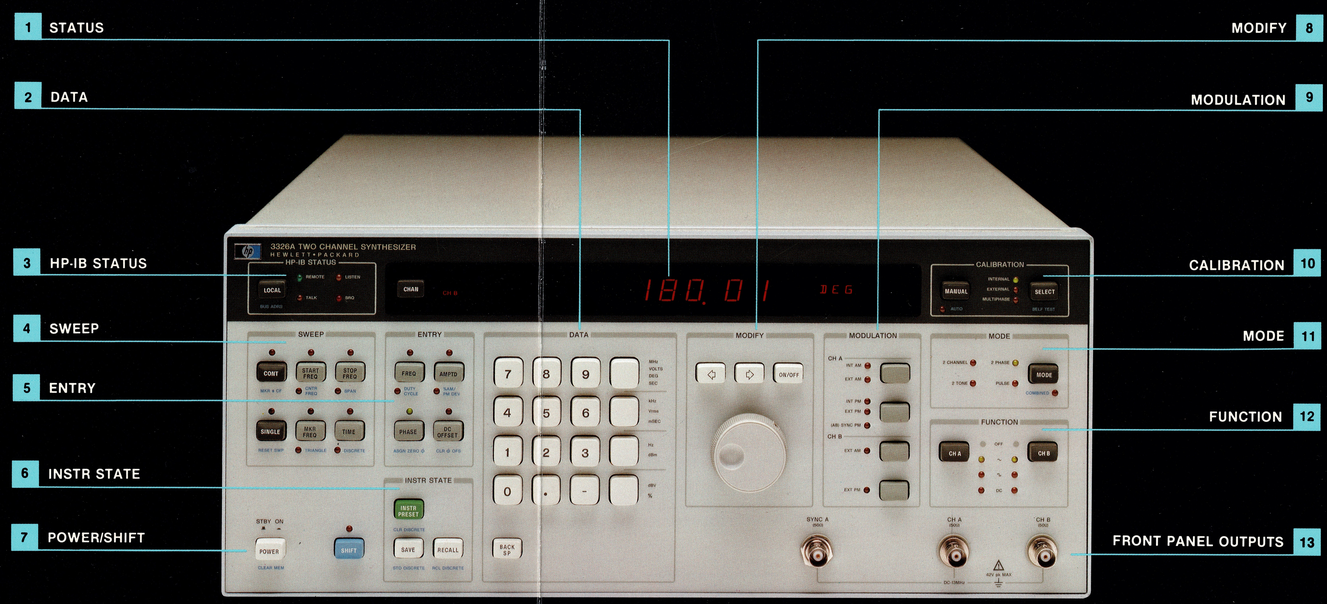
~, ⊓⊔, and **DC** indicators indicate function selected with CH A and CH B keys.

HV keys enable the high voltage option for low impedance outputs with levels up to 40 Vpp.

13 FRONT PANEL OUTPUTS

SYNC A output provides a TTL square wave with same frequency as channel A. SYNC A output impedance is 50 Ω.

CH A and **CH B** outputs provide standard impedance of 50 Ω. High voltage output impedance is less than 2 Ω to 50 kHz and less than 10 Ω to 1 MHz.



⚠ **CAUTION**

The maximum peak voltage (ac + dc) that can be safely applied between the chassis and the outer conductor of the HP 3326A input and output connectors is ±42 Vpk.

SALES & SUPPORT OFFICES

Arranged alphabetically by country

Product Line Sales/Support Key

Key	Product Line
A	Analytical
CM	Components
C	Computer Systems Sales only
CH	Computer Systems Hardware Sales and Services
CS	Computer Systems Software Sales and Services
E	Electronic Instruments & Measurement Systems
M	Medical Products
MP	Medical Products Primary SRO
MS	Medical Products Secondary SRO
P	Personal Computation Products
*	Sales only for specific product line
**	Support only for specific product line

IMPORTANT: These symbols designate general product line capability. They do not insure sales or support availability for all products within a line, at all locations. Contact your local sales office for information regarding locations where HP support is available for specific products.

HP distributors are printed in italics.

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If there is no sales office listed for your area, contact one of these headquarters offices.

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After Jan. 1, 1984
47th Floor, China Resources Bldg.
26 Harbour Rd., Wanchai
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Biotron S.A.C.I.M. e I.
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Hewlett-Packard France
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A,M

Blue Star Ltd.
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Blue Star Ltd.
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Blue Star Ltd.
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A,M

Blue Star Ltd.
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***SECUNDERABAD** 500 003*
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Telex: 0155-459
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A,E

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T.C. 7/603 Poornima
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***TRIVANDRUM** 695 013*
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E

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Jl. Kutei No. 11
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A,E,M,P*

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Cardiac Services Ltd.
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M

ISRAEL

Eldan Electronic Instrument Ltd.
P.O.Box 1270
JERUSALEM 91000
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JERUSALEM 94467
Tel: 533 221, 533 242
Telex: 25231 AB/PAKRD IL
A

Electronics Engineering Division
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CH,CM,CS,E,M,P

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Hewlett-Packard Italiana S.p.A.
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Hewlett-Packard Italiana S.p.A.
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Hewlett-Packard Italiana S.p.A.
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Shin-Kyoto Center Bldg.
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Karasuma-Nishiiru
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Computer Information Systems
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Mushko & Company Ltd.
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***KARACHI** 0302*
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Cía Electro Médica S.A.
Los Flamencos 145, San Isidro
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PHILIPPINES
The Online Advanced Systems Corporation
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Intercambio Mundial de Comércio S.A.R.L.
P.O. Box 2761
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Tel: (19) 53-21-31, 53-21-37
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Soquimica
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1298 ***LISBOA** Codex*
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P

Telectra-Empresa Técnica de Equipmentos Eléctricos S.A.R.L.
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Nasser Trading & Contracting
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A

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M

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